JOHN FLUKE MANUFACTURING CO., INC. / P. O. Box 7428 • Seattle 33, Washington

800 Series

MP-38157

FLUKE

SERVICE MANUAL

SPECIFICATIONS

INPUT POWER: 117 or 234 volts, 50 - 60 cps.

VOLTAGE RANGE: 0 to 500 volts DC.

INPUT RESISTANCE: Infinite at null as indicated by zero deflection of the meter. 2000 megohms per volt of input voltage for 0.005 volt unbalance as indicated by meter.

NULL RANGES: 1 volt and 10 volt full scale.

ACCURACY: ±0.05% of actual voltage from 10 to 500 volts. ±0.1% of actual voltage, or 5 MV, whichever is greater, below 10 volts.

RESOLUTION: 0.01 volt read directly on cali-controls. Greater resolution available by reading meter.

DIMENSIONS: Cabinet Model 13" high x 9-3/4" wide x 14" deep. Rack Model 8-3/4" high x 19" wide x 16-3/4" deep.

FINISH: Smooth grey panel. Grey baked wrinkle case.

WEIGHT: Cabinet 26 lbs., Rack 30 lbs.

PRICE: Cabinet Model $385.00 f.o.b. factory, Mountlake Terrace, Washington. Rack Model $405.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Hails Lake TLX 852

JOHN FLUKE MFG. CO., INC.

MODEL 800 TEST PROCEDURE

1. VISUAL INSPECTION. Check every soldered connection on both boards and on the Range switch. Touch each connection with a probe and proceed around each board and switch in orderly fashion. DO NOT INSPECT BY A CASUAL GLANCE. A THOROUGH INSPECTION REQUIRES AT LEAST 10 MINUTES. Be sure resistors on Kelvin-Varley switches are properly soldered and aligned parallel to each other.

   Pay special attention to the X10, X1, and X.01 switches. Located as they are at the corners of the switch tray, the resistors on these switches are more likely to be chipped or pushed out of alignment than on the other switches. Also be sure that resistors are not rubbing against the long screws holding the switch wafers together.

   Examine the deposited carbon resistors on the Range switch to be sure that none is shorted out. See that the end ferrule of one resistor is not jammed against the body of an adjacent resistor. Inspect all eyelets on both circuit boards - solder must be flowed smoothly over the eyelets to the copper foil, making a good electrical connection.

   Reheat any suspected connection. THERE IS NEVER ANY EXCUSE FOR A POOR OR UNSOLDERED CONNECTION GETTING BY YOUR INSPECTION ! If interrupted while inspecting, make a note of the point at which you stopped and resume at that point. Adopt a set sequence of inspection and follow that routine every time. DO NOT DEVIATE FROM THE PROCEDURE ONCE ESTABLISHED.

   Whenever a poorly soldered connection or particularly a completely unsoldered connection is found, immediately check this same connection on several other instruments. Frequently a connection missed on one unit in a production run is missed on every unit in the run. If one other unit is found with the same unsoldered connection, notify your supervisor at once.

   Give the instrument a thorough mechanical inspection. Tighten all nuts, bolts, and sheet metal screws. Be sure there is a lockwasher between the Range switch and the panel on the rack-mounting model. Check the engraving on the front panel, especially look for the decimal points on the X.1 and X.01 switches. Also be sure that the dial plates behind the front panel are not scratched or rubbing against the panel. Be sure the knobs are secure on their shafts, are not scratched or chipped, and are properly positioned. Check the Range switch for ease of operation; if it binds, slightly loosen the nuts on the rear of the switch, realign the ceramic decks, and re-tighten the nuts.

When the completed instrument comes to 800 Test from Assembly, the 12AU7 in the reference supply board is missing. A 12AU7 which doesn't quite meet the stringent requirements for use on the VTVM board should be used here since the reference board application is highly uncritical. Be sure all other tubes are in their proper sockets.

2. CHECK INPUT POWER AND CHECK FOR OVERHEATING OF ANY COMPONENTS.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	49-53 watts	117V

Be sure instrument is OFF, plug into wattmeter, set Variac to 0, plug wattmeter into Variac, and Variac into AC line. Turn 800 ON and slowly raise line voltage, watching wattmeter for any signs of overload. If unit draws between 49 and 53 watts, there are no major defects in the instrument and the following checks may be made:

1. Be sure tube filaments are lit.
2. Zero meter with MTR ZERO knob.
3. Measure these voltages with a vacuum-tube voltmeter from common negative (negative side of C2) to the point designated: 960V at hot side of C2, 650V at pin 2 of V2, 500V at pin 3 of V4, 150V at hot side of C101, 109V at pin 5 of V101.
4. Operate Range switch to each position to be sure meter isn't pinned due to some internal trouble or circuit defect.
5. Place instrument on rack to warm up for 8 hours.

TROUBLE. If wattage exceeds 53 watts, shut off unit and check for shorted C1 or C2. Check also resistance from common negative to pin 1 of V4 - should be approximately 100,000 ohms. Resistance from pin 3 of V4 to common negative should be at least 65,000 ohms. Check for shorted pilot lights in meter or shorted tube heaters. Check for shorted C101 in VTVM board. Also check to see that VR tube on VTVM board is lit, indicating no short circuit anywhere in VTVM "B" supply wiring. Check for arcing in the 5Y3 - there must be none after the first few seconds of operation.

3. CHECK Ebb OF MAIN SUPPLY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	920-980V	117V

DC Voltage (Ebb) 950V ±30V
RMS AC Ripple (Ebb) <20V

With VTVM set to 1,500V range, read from common negative of C2 (1 mfd -1,000V DC Capacitor) to positive terminal of C2. Should read 950V, ±30V Be sure to

use blocking capacitor when measuring ripple across C2.

TROUBLE. Indicated trouble will probably lie in the pre-regulator or final regulator circuit. Steps 4 and 7 will indicate which one.

4. CHECK DC OUTPUT OF PRE-REGULATOR.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	620-670V	117V

With VTVM set to 1,500V range, read from common negative of C2 to pin 2 of V2 (6AQ5); voltage should be 645V ±25V.

TROUBLE. If voltage is not within tolerance, check first to see if instrument is regulating. With a line voltage change of 100 to 130 volts, output voltage should not vary more than 8 volts. If supply is regulating (as shown by a ripple voltage of less than 150 mv) but output voltage is outside limits, check voltage from pin 5 of V5 to common negative - must be 150V plus or minus 3V. If outside these limits, replace V5. Also check R5 and R6 - if off by more than 1%, replace. If supply is not regulating, pull V4 to remove loading effect of final regulator circuit. If trouble clears up, fault is in final regulator circuit. If trouble persists, replace V3 (6AU6) and V2 (6AQ5) in this order. Other things to check are C3 for short circuits or leakage, R2, R3, and R4, and all connections for poor soldering or shorts. Check the printed circuit board for any scratches which might cause an open circuit or a drop of solder which might cause a short circuit.

5. CHECK RIPPLE IN OUTPUT OF PRE-REGULATOR.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	20-150 mv	100-130V

With an RMS AC VTVM, check ripple from pin 2 of V2 to common negative on C2. As line voltage is varied, ripple should change from approximately 25 mv at 130V AC line voltage to no more than 150 mv at 100V AC line voltage.

TROUBLE. If ripple exceeds 150 mv, at 100V AC, change V3 (6AU6). If this does not cure the trouble, refer to TROUBLE section of step #4.

6. LINE VOLTAGE AT LOSS OF CONTROL.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<100V	100V

Observe ripple as in step #5 as line voltage is lowered below 100V. Loss of regulation as indicated by suddenly increasing ripple must occur below 100 volts.

TROUBLE. If loss of control occurs above 100 volts AC, replace V3 (6AU6). If this does not help, refer to TROUBLE section of step #4.

7. CHECK OUTPUT VOLTAGE OF FINAL REGULATOR.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	500V ±4V	117V

With VTVM in 1,500V range, measure the output voltage from pin 3 of V4 (12AU7) - should be 500V ±6V. Rotate ADJ. CAL. knob from one extreme to other and check voltage change. Change must be approximately 3 volts.

TROUBLE. If trouble is present, check for rattle, proper regulation, and output voltage with an 801. Turning P1 (ADJ. CAL. pot) and adjusting P6 (5 k Trimit pot) should vary the output voltage over a range of approximately 12 volts. This range should include the 500 volt point. If it does not, check the voltage at pin 5 of V7 - it should be 166 ±3V. If this voltage is out of tolerance, replace V7 and V8 (OG3 tubes). If trouble persists, replace V4 (12AU7) and V6 (12AX7) in that order. Should the output voltage still not reach 500 volts, check R18 (158 k), R17 (320 k), R7 (149 k), R9 and R10 (300 k), and R13 (250 k). If the output voltage still cannot be adjusted to 500 volts, set Range switch to CAL position; this disconnects the 5-dial Kelvin-Varley divider from the output. If trouble clears up, determine where divider is faulty.

8. CHECK RIPPLE IN MAIN 500V REFERENCE SUPPLY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<8 mv	100-130V

With AC RMS VTVM connected from common negative to pin 3 of V4, vary line voltage from 100 to 130 volts. Ripple should not exceed 8 mv.

TROUBLE. If ripple is too high, replace V3 (6AU6); if trouble still persists, refer to TROUBLE under step #7.

9. CHECK LINE VOLTAGE AT LOSS OF CONTROL.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<100V	100V

Observe ripple as in step #8 as line voltage is lowered below 100V. Loss of

regulation as indicated by suddenly increasing ripple must occur below 100 volts.

TROUBLE. If loss of control occurs above 100 volts AC, replace V3 (6AU6). If this does not help, refer to TROUBLE section of step #7.

10. CHECK GRID-CATHODE VOLTAGE OF V4 (12AU7).

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	Not less than -2V	100V

Set line voltage to 100 volts, turn Adj. Cal. knob to maximum counter-clockwise position, set VTVM to 5V range and DC (-) polarity. Connect common or ground lead to pin 3 of V4 (this makes case of VTVM 500V hot to chassis of 800 under test - stay clear while making this test) and connect probe to pin 2 of V4. Adjust P6 (5 k Trimit pot) for minimum voltage reading. Bias must not be less than -2.0 volts.

TROUBLE. If bias is less than -2.0 volts, replace V4 (12AU7). Should trouble persist, check R5 (500 k) and R6 (144 k). If off by more than 1%, replace.

11a. CHECK STABILITY OF REFERENCE SUPPLY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<40 mv	100-130V

Set ADJ. CAL. knob to vertical position and AC line voltage to 100 volts. Adjust P6 (5 k Trimit pot) for an output voltage of 500 as read on a Ⓕ Model 800 or 801. When reference supply output is nulled, run AC line voltage up to 130 volts and, after a short wait for the reference supply to stabilize again, look for meter deflection on 800 or 801 used as a standard. The stability of the 500 volt supply should be less than ±40 mv (2 small divisions) and should never exceed ±50 mv (2-1/2 small scale divisions).

11b. At this point give unit first NWT test - tap chassis several times on all sides and check for erratic output - 500 volts as observed on monitoring 800 or 801 must remain steady except for slight shift of a small division or so caused by minute changes in tube geometry.

TROUBLE. If the regulation is unsatisfactory, replace V6 (12AX7) with an aged tube and recheck. If the regulation is okay, but output voltage rattles or changes erratically, see TROUBLE under step #7. If trouble persists, go to TROUBLE IN STEP #4. If this doesn't clear trouble, see step #3. Should

the trouble still exist, give unit a thorough visual inspection as in step #1 because something was missed.

12. CHECK INTERNAL CALIBRATION SYSTEM (1V SAMPLE).

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	About 1V	117V

Connect VTVM from common negative to top of R16 (509 ohms) - voltage should be slightly over one volt. If 1V sample is okay, rotate 5 ohm pot (P2) slowly from one end to the other. 1 volt reading should change about 1% smoothly. If there is any sudden changing in the 1 volt reading, rotate P2 rapidly several times to clean wiper. If trouble persists, tag unit and send back for new pot. If okay, plug in the standard cell in the 800 under test. Set Range switch to CAL. position and turn OP-CAL switch to CAL position lightly. Meter needle should deflect less than one large division. If it pins violently, cell is wired to plug backwards. Tag instrument and reject.

TROUBLE. If voltage is not correct, check value of R15 and R19 (125 k). Voltage drop across R15 and R19 should be approximately 249.49 volts each as read on Ⓕ Model 800 or 801 but must be within 500 mv of each other.

THIS COMPLETES CHECKING OF MAIN BOARD. TURN UNIT AROUND AND PROCEED WITH TESTING OF VTVM BOARD.

13. CHECK DC OUTPUT VOLTAGE ACROSS C101.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	135-165V	117V

Connect VTVM across C101 filter capacitor - should read 150V ±15V.

TROUBLE. If voltage is not within tolerance, disconnect C101 and substitute a good 8 mfd capacitor. If the original capacitor is okay, check for excessive heating of selenium reactifier X101, or check by substitution. Also be sure that V101 (OB2) is glowing.

14. CHECK RIPPLE ACROSS C101.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<6V	117V

With AC RMS VTVM, check ripple at same points as in step #13 above. Should be less than 6 volts.

TROUBLE. See TROUBLE under step #13.

15. CHECK DC VOLTAGE ACROSS V101 (OB2).

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	105V ±3V	117V

With VTVM check DC voltage from common negative of small board (negative terminal of C101) to pins 1 or 5 of V101. Should read 105V ±3V.

TROUBLE. If voltage is out of tolerance, replace V101. If trouble persists, see TROUBLE under step #13.

16. CHECK RIPPLE ACROSS V101 (OB2).

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<300 mv	117V

Using AC RMS VTVM, check ripple from common negative to pins 1 or 5 of V101. Should be less than 300 mv.

TROUBLE. If ripple is excessive, replace V101. If trouble persists, see TROUBLE under step #13.

17. CHECK V102 (12AU7 or 7316) FOR GRID CURRENT.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
1V	000.00	<1/2 small scale division	117V

Zero meter with P101 (MTR ZERO), then short the input binding posts, being sure to connect the shorting bar to the minus (-) terminal first. Observe closely for movement of the meter pointer to the left. Must not exceed 1/2 of one small scale division. Repeat test several times for safety.

TROUBLE. If grid current is excessive, replace V102 with an aged tube and repeat test.

18. CHECK STABILITY OF VTVM TUBE (V102 - 12AU7 or 7316).

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<3 small scale divisions	100-130V

Set AC line voltage to 100V, wait a few moments for voltages to stabilize, and adjust P101 (MTR ZERO) for zero on the meter. Raise AC line voltage to 130V, and see that after the needle has stopped moving, it is within 3 small scale divisions of zero. When meter is zeroed, pointer on P101 must be vertical, plus or minus 90 degrees.

TROUBLE. If needle offset is excessive, replace V102 with an aged tube, either 12AU7 or 7316 being usable, but 7316 preferred. Then repeat step #17.

19. ADJUST VTVM METER SENSITIVITY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<1-1/2 small scale divisions	117V

Zero meter with P101 (MTR ZERO), apply an accurate 500V DC to input terminals of 800 under test, and adjust P102 for full right scale deflection. Remove voltage, recheck zero, then apply voltage with polarity reversed. Needle should be within 1-1/2 small divisions of end scale. If meter reads in excess of 1-1/2 small divisions reverse input again and adjust P102 slightly to split the error. That is, if meter reads 2 small divisions to the right of full scale on the left hand side, adjust P102 to cause the meter to read about 1/2 small division to the right of zero on the right hand side. This will reduce the error on left side to approximately 1-1/2 small divisions.

TROUBLE. If pointer comes to rest more than ±2 small scale divisions from left end of scale, replace V102 (12AU7 or 7316) and repeat tests #17 and #18. If this does not cure or reduce the error, replace the meter.

20. CHECK METER LINEARITY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<1-1/2 small scale divisions	117V

Apply an accurate 500 volts to input terminals of 800 under test. Reduce input voltage in steps of 100 volts. Linearity of meter at 100 volt steps must be less than 1-1/2 small scale divisions. Reverse polarity of input voltage and work out to other end of scale, again in 100 volt steps.

TROUBLE. If linearity exceeds 1-1/2 small scale divisions, replace meter, then repeat steps #17, #18, #19 and #20.

21. CHECK FOR LEAKAGE FROM GRID OF VTVM.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<1/4 small scale division	117V

Zero meter with P101 (MTR ZERO). Rotate X100 dial from 0 to 4, and check for needle offset to left. Movement must not exceed 1/4 of one small scale division.

TROUBLE. If meter offset due to leakage is excessive, it will be necessary to wash certain components. The red PLUS input post should be washed ONLY in denatured alcohol, as it is soluble in petroleum base solvents. The ceramic Range switch must be washed in Metriclene Solvent M4. In trouble-shooting older models of 800, the grid input leads may be of ordinary hookup wire and may require replacement with Teflon insulated wire.

22a. CHECK LINEARITY OF KELVIN-VARLEY VOLTAGE DIVIDER BY COMPARISON WITH ESI DECADE VOLTAGE DIVIDER. (Special high accuracy divider Model X376)

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	499.9 10	<.01%	117V

Zero meter of 800 under test. Set dials on ESI Decade Voltage Divider to 499.99 10 and dials on 800 to 499.9 10. Connect the test lead from COMMON at input of ESI D. V. D. to common negative on reference supply board. Connect the test lead from 500V input on ESI D. V. D. to pin 3 of V4 (12AU7) on reference supply board. Connect OUTPUT (positive) and COMMON (negative) to input of 800. As output of ESI D. V. D. is plugged into 800, a slight offset of the meter may be noted. If it exceeds 1/4 of one small scale division, repeat step #17. If offset is less than 1/4 of one small scale division, proceed with test but subtract error due to grid current before determining error present in K-V.

1. Turn RANGE to 500V, ESI D. V. D. to 399.99 10 and 800 to 399.9 10. RANGE switch must be in 500V position during changes of voltage to prevent pinning the meter.

2. Return RANGE switch to 1V position; needle should be within 40 mv of zero (.01% of 399.9 10 volts).

3. Repeat above procedure for 299.9 10, 199.9 10, and 099.9 10 volts. Error must not exceed 30 mv, 20 mv, and 10 mv, respectively.

4. Repeat above procedure with the X10 switch, turning it down in 10 volt steps, and returning RANGE to 10V before each voltage change. Error at 009.9 10 must not exceed 5 mv.

5. Repeat above procedure for the remaining switches, X1, X.1, and X.01. Error for these steps must not exceed 5 mv.

TROUBLE. Poor correspondence is caused by one of two things, an out-of-tolerance resistor on one of the five switches or contaminated switch wafers. Since ABSOLUTELY NO CORROSIVE FLUX is allowed in the soldering of resistors to these switches, it is almost certainly a defective resistor.

Usually error will increase gradually up to a point and then fall off abruptly as voltage dials are rotated. The defective resistor will usually be found at this point. If error is very large the defective resistor can be found with an ohmmeter. Otherwise, use a Model 800 or 801 to measure the voltage drops across each resistor on the switch in question. The defective resistor is very easily detected in this manner.

There is always the possibility of a short circuit in the Kelvin-Varley. With all five dials at zero, dial up slowly while watching the OG3 regulator tubes in the reference supply. If they start to dim, quickly turn instrument off and give K-V a thorough visual inspection. Look for small metal hairs that might cause trouble, also look for loose drops of solder and excessive solder on switch terminals that might spread enough to touch one of the long metal screws holding the switch wafers together. Look for any unclipped lead-ends that might cause a short circuit. After the short has been cleared, replace the 12AU7 in the reference supply since, if the instrument was operated with the short circuit present, the series-passing tube (12AU7) was almost surely overloaded. If not replaced, this tube would cause erratic changes in the output voltage from the reference supply.

If the trouble does not seem to be either a short circuit or a defective resistor, check for mis-wiring, preferably by checking against an 800 known to be operating correctly.

22b. CORRESPONDENCE TO STANDARD AT 100.00V.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	100.00	<10 mv	117V

Set ESI Decade Voltage Divider to 099.99 10, 800 to 100.00, and RANGE to 1V. Connect as in step #22a. Error should be less than 10 mv (1/2 of one small scale division). Now set 800 dials to 099.9 10 and recheck correspondence again. Error must be less than 10 mv.

TROUBLE. See TROUBLE under step #22a.

23a. CHECK ACCURACY OF 1V AND 10V RANGES.

23b.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	255.00	<3 small scale divisions	117V

Set ESI Decade Voltage Divider to 255.000 and 800 to 255.00. Connect as in step #22a. Set Range switch to 1V; turn X1 dial from 5 to 6, and from 5 to 4. Total error must not exceed 3 small scale divisions and end scale error at either end must not exceed 2 small scale divisions. Reset X1 to 5 and turn

Range switch to 10V. Rotate X10 dial from 5 to 6 and from 5 to 4. Total error must not exceed 3 small scale divisions and end scale error at either end must not exceed 2 small scale divisions.

TROUBLE. If total error or end scale error is excessive, see TROUBLE under section 22a. Also check resistors R108 (9 megohm), R109 (980,000 ohms), and R110 (20,000 ohms). If off by more than 1%, replace.

24. CHECK KNOB POSITION OF METER ZERO ADJUST WITH METER PROPERLY ZERO SET.

Must lie within ±90° of vertical.

25. CHECK KNOB POSITION OF ADJ. CAL. WITH UNIT PROPERLY CALIBRATED.

Must lie within ±90° of vertical.

26. CHECK INTERNAL CALIBRATION SYSTEM.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
CAL.	000.00	0	117V

First set reference supply to an accurate 500 volts. Check mechanical meter adjustment for zero, then turn CAL. knob momentarily. Meter should deflect somewhere within one large scale division of zero. Turn CAL. knob again and, with an insulated screwdriver, turn P2 (5 ohm rheostat) through its entire range, watching for any sudden movement of the meter. Needle should pass through zero. Adjust P2 so that there is no perceptible movement of the needle whether CAL. knob is turned or not. Release CAL. knob and check mechanical zero again for accuracy.

TROUBLE. Check wiring of standard cell plug and CAL. switch. If trouble still persists, refer to TROUBLE in step #12.

THIS COMPLETES THE PRE-TEST OF THE 800. PLACE THE INSTRUMENT IN ITS CASE AT THIS POINT AND SET IT ON THE WARMUP RACK FOR AT LEAST THREE HOURS WARMUP BEFORE CALIBRATION.

CALIBRATION OF MODEL 800

This consists of two parts, a hot check and a cold check. The cold check is made after unit has operated for one-half hour and after having cooled for at least 3 hours. The hot check is made after the instrument has had at least 32 hours ageing time and not less than three hours of warmup time in its case. The purpose of these two checks is to show up any resistors with abnormally high temperature coefficients of resistance or standard cells with excessive hysteresis. The unit is calibrated "hot".

27. ADJUSTMENT OF VTVM METER SENSITIVITY.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	000.00	<1-1/2 small scale divisions	117V

Zero meter with MTR ZERO, apply an accurate 500V DC to input terminals of 800 under test, and adjust P102 for full right scale deflection. Remove voltage, recheck zero, then apply voltage with polarity reversed. Needle should be within 1-1/2 small scale divisions of end scale, either left or right. Total error must not exceed 2 small scale divisions.

TROUBLE. See TROUBLE in step #19.

28. CALIBRATE 500V REFERENCE SUPPLY AGAINST INTERNAL STANDARD CELL.

RANGE SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	499.9 10	<20 mv	117V

Set voltage standard (ESI X194) to 500V and adjust output of 301E to exactly 500 volts as indicated by the L & N galvo. Carefully zero meter of 800 with MTR ZERO. Connect output of 301E to input terminals of 800 under test and adjust 800 meter for zero with ADJ. CAL. knob. Now pull instrument part way out of its case, turn Range switch to CAL. position and rotate CAL. knob. With a screwdriver adjust P2, the 5 ohm rheostat, until no needle movement is noted when CAL. switch is operated. It is extremely important that this operation be very carefully performed since it determines in large part the overall accuracy of the instrument. Switch back to 1V position and recheck nulling against 500 volt input from standard. If still within ±1 small scale division (20 mv), seal P2 with a drop of cement.

TROUBLE. See TROUBLE IN step #7.

"COLD" CALIBRATION CHECK

29. Repeat steps #27 and #28 after instrument has operated for 20 to 30 minutes
30. after at least three hours cooling time from turnoff after hot check. Tolerance of step #30 (28 repeated) is <50 mv. If any calibration error exceeds .01%, split it. For example, in step #27, if meter reads to the right 100 mv (.02%) with 500 volts input from the voltage standard (after careful calibration using CAL. knob and ADJ. CAL. knob), proceed as follows: Turn ADJ. CAL. knob until meter reads to the right 50 mv (.01%) and re-set the 5 ohm rheostat P2. This splits the error (which may be due to slightly high standard cell temperature coefficient, high standard cell temperature, voltage hysteresis, high or opposite sign resistance temperature coefficient, or any combination of these effects) so that it lies within .01% both hot and cold. If error exceeds .02%

notify foreman of test or engineering department.

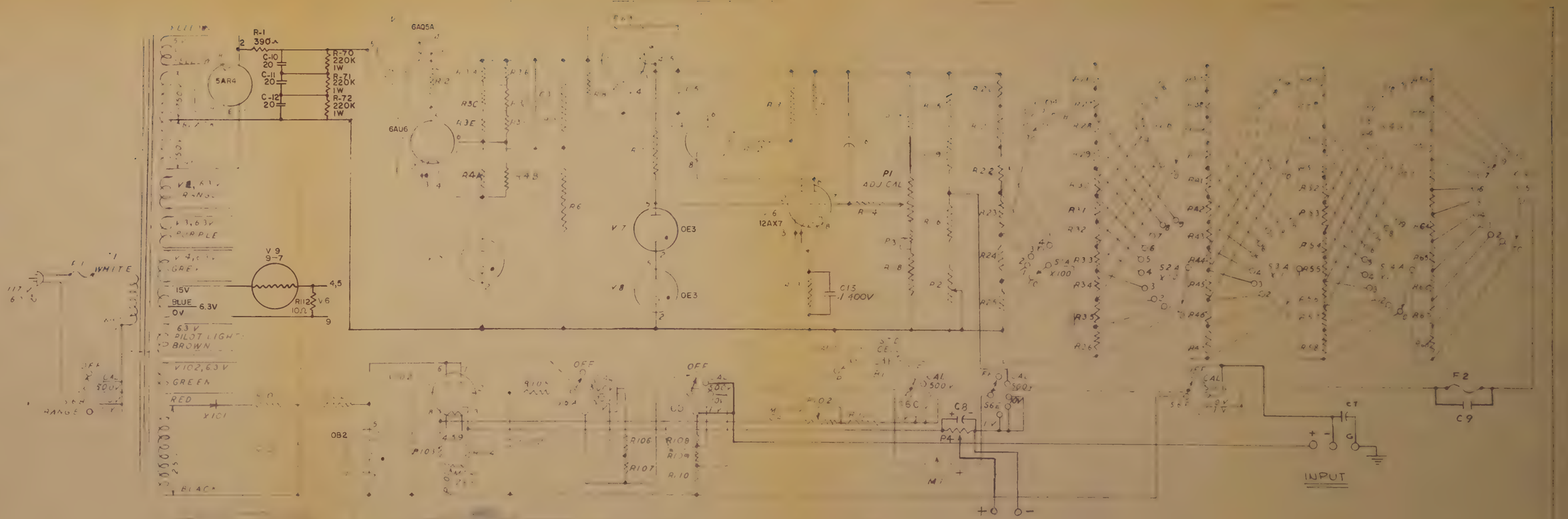
PREPARE INSTRUMENT FOR SHIPPING (BUTTONING UP).

When the instrument has passed both hot and cold checks, it is ready to be buttoned up for shipment. First, give it a visual inspection for loose tubes, nuts, bolts, knobs, dial plates, and switches. Check for rubbing dial plates, binding switches, and any engraving which might have been overlooked. Using a rubber stamp and ink pad, print "2 AMP" on rear of instrument between fuse holder and line cord.

Now the instrument is ready to be sprayed. When doing this, hold a piece of cardboard over all switches so as not to get any plastic spray onto the contacts. Also be careful not to spray the 5 ohm pot on the reference supply board as it will become erratic due to poor contact. The instrument is now ready to be placed in its case.

Check the rubber feet on the case to be sure they are on tight, then place instrument in the case. Place a large Phillips head screw in the lower hole on the rear of the case. Take another large screw of the same type, place a plastic clamp for the line cord on it, then place screw in top hole on rear of case and tighten.

The instrument is now ready for shipping.



SERIES ABOVE

2-1-54

FLUKE

TECHNICAL DATA

801 VOLTMETER

MODEL 801 DIFFERENTIAL DC VOLTMETER

FEATURES

- Accuracy 0.05% of input voltage from 0.1 to 500 volts
- Four potentiometric ranges
- Infinite input resistance at null over the entire 500 volt range
- Eight search and VTVM ranges
- Standard cell reference
- Automatic lighted decimal for fast, direct digital read-out

DESCRIPTION

The Model 801 is a sensitive, highly accurate differential voltmeter with a basic input range of 0 to 500 volts DC. It is self-contained, portable, and virtually impossible to damage by accidental overload. The value of the unknown voltage being measured is presented on a five-decade digital readout with illuminated decimal point. Circuit loading problems are eliminated as this unit has infinite input resistance at null for all voltage measurements up to 500 volts.

The basic elements of the 801 are a standard cell, an extremely stable 500 volt reference source, a precision five-dial Kelvin-Varley voltage divider and a chopper stabilized null detector.

In order to set the reference voltage with high accuracy, the standard cell comparison circuit is factory-set precisely to the actual standard cell voltage available in each instrument. This procedure eliminates resistor tolerances in the comparison circuit. The same approach is used in the decade divider resulting in these strings having an accuracy of better than 0.01%. Resistors on the five Kelvin-Varley dials are matched to each other and, in turn, the completed dials are matched units. The chopper-stabilized null detector in the Model 801 has exceptionally high stability allowing true null to be determined accurately. This stability plus the four ranges of the detector further insures accuracy and ease of operation.

NOTE THE MANY USES OF THE MODEL 801

The Model 801 is exceptionally versatile in application. Here are a few of its many uses:

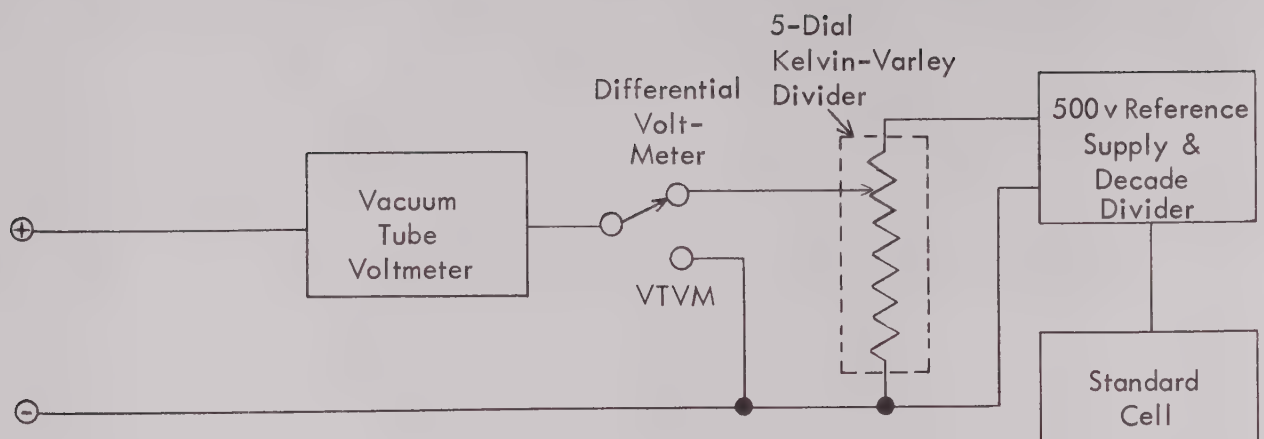
Calibration, testing and stability measurements of regulated power supplies.

Instrument calibration.

DC voltage measurements in high resistance circuits as well as low resistance sources including photocells, standard cells, computers, power supplies, batteries, tube circuits, thermocouples, storage devices, etc. All of these measurements may be made with accuracy and without loading error.

As a substitute for conventional potentiometers, particularly for voltages above 1.6 v where the loading effect of voltage attenuators cannot be tolerated. Note that the Model 801 is entirely self-contained and is designed for portability and operation by unskilled personnel.

Precise voltage measurements to 5000 volts may be made with the Model 801 by using the John Fluke Model 80A accessory volt boxes.



BASIC BLOCK DIAGRAM

SPECIFICATIONS

AS A PRECISION POTENTIOMETER

RANGES:

Input Voltage Range	*Null Voltage Ranges	Input Resistance per volt of input voltage At Null	1% Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	"	1000 Meg
5-50	1-0-1	"	1000 Meg
	0.1-0-0.1	"	1000 Meg
0.5-5	0.1-0-0.1	"	1000 Meg
	0.01-0-0.01	"	10000 Meg
0-0.5	0.1-0-0.1	"	1000 Meg
	0.01-0-0.01	"	10000 Meg

*Any null range may be used with any input voltage range; recommended ranges are shown above.

ACCURACY:
±0.05% of input voltage from 0.1 v to 500 v; below 0.1 v ±0.1% of input voltage or 0.00005 v whichever is greater.

RESOLUTION:

Input Voltage Range	Dial Limits Volts	Meter Limits on Recommended Null Range Volts
50-500	0.01	0.005
5-50	0.001	0.0005
0.5-5	0.0001	0.00005
0-0.5	0.00001	0.00005

AS A VACUUM TUBE VOLTMETER

VOLTAGE RANGES:
±500, ±50, ±5, ±0.5 and ±10*, ±1*, ±0.1*, ±0.01* volts DC full-scale
*These ranges obtained by setting null range to desired sensitivity and five voltage dials to zero.

ACCURACY: 4% on all ranges

INPUT RESISTANCE:
10 megohms for all voltage ranges except 0.1 and 0.01 which have 1 megohm input resistance

GENERAL FEATURES

STABILITY OF REFERENCE:
±0.01% for 25% change in line voltage
±0.01% per hour after 30 minute warmup

SETABILITY OF REFERENCE:
Reference supply can be set to 500 volts
±0.01% or better against built-in standard cell

STABILITY OF METER READING:
4% of full-scale for 25% change in line voltage

INPUT POWER:
117 volts, 50/60 cycle

DIMENSIONS:
Cabinet Model - 13" high, 9-3/4" wide, 14" deep
Rack Model - 8-3/4" high, 19" wide, 16-3/4" deep

WEIGHT:
Cabinet Model - 28 lbs.
Rack Model - 33 lbs.

PRICE:
Cabinet Model - $485.00 f.o.b. Factory
Rack Model - $505.00 f.o.b. Factory

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho U.S.A.

Electronics FOR INDUSTRY

FLUKE
JOHN FLUKE MANUFACTURING CO., INC.
P.O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

JOHN FLUKE MFG. CO., INC.

MODEL 801 TEST PROCEDURE

1. VISUAL INSPECTION - Check every soldered connection on both boards and on the Range and Null switches. Touch each connection with a probe and proceed around each board and switch in orderly fashion. DO NOT INSPECT BY A CASUAL GLANCE. A THOROUGH INSPECTION REQUIRES AT LEAST 10 MINUTES. Be sure resistors on Kelvin-Varley switches are properly soldered and aligned parallel to each other.

   Pay special attention to the "B", "C", and "E" switches. Located as they are at the corners of the switch tray, the resistors on these switches are more likely to be chipped or pushed out of alignment than on the other switches. Also, be sure that resistors are not rubbing against the decimal lights on the front panel since this could ruin several precision resistors.

   Examine the deposited carbon resistors on the Null and Range switches to be sure that none is shorted out. See that the end ferrule of one resistor is not jammed against the body of an adjacent resistor. Inspect all eyelets on both circuit boards - solder must be flowed smoothly over the eyelets to the copper foil, making a good electrical connection.

   Reheat any suspected connection. THERE IS NEVER ANY EXCUSE FOR A POOR OR UNSOLDERED CONNECTION GETTING BY YOUR INSPECTION! If interrupted while inspecting, make a note of the point at which you stopped and resume at that point. Adopt a set sequence of inspection and follow that routine every time. DO NOT DEVIATE FROM THE PROCEDURE ONCE ESTABLISHED.

   Whenever a poorly soldered connection or particularly a completely unsoldered connection is found, immediately check this same connection on several other instruments. Frequently a connection missed on one unit in a production run is missed on every unit in the run. If one other unit is found with the same unsoldered connection, notify your supervisor at once. Do not repair any poorly soldered work - affix reject tag and send back for repair.

   Give the instrument a thorough mechanical inspection. Check all nuts, bolts, and sheet metal screws for tightness - reject any units with loose hardware noting fault on reject tag. Be sure there are lockwashers between the Range and Null switches and the panel on the rack mounting model. Check the engraving on the front panel, especially look for the decimal points on the Range switch and the .1V - .01V zero adjust knobs. Also be sure the dial plates behind the front panel are not scratched or rubbing on the panel. Be sure that the knobs are secure on their shafts, are not scratched or chipped, and are properly positioned. Check the Range and Null switches for ease of operation; if they bind, slightly loosen the nuts on the rear of the switches, realign the ceramic decks, and retighten the nuts.

   When the completed instrument comes to 801 Test from Assembly, the 12AX7 in the small board and the 12AU7 in the large board are missing. Be sure all other tubes are in their proper sockets.

These are non-critical circuit elements and tubes which do not meet the more stringent requirements of V6 (12AX7 differential amplifier on large board) and V104 (12AU7 VTVM tube on small board) will perform very well in these sockets.

2. CHECK INPUT POWER AND CHECK FOR OVERHEATING OF ANY COMPONENTS.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	72-78 watts	117V AC

Be sure set is OFF, plug into wattmeter, set Variac to 0, plug wattmeter into Variac and Variac into AC line. Turn 801 ON and slowly raise line voltage, watching wattmeter for any signs of overload. If unit draws between 72 and 78 watts, there are no major defects in the instrument and the following checks may be made:

1. Be sure tube filaments are lit.
2. Zero meter with VTVM ZERO ADJ. knob.
3. Measure these voltages with a vacuum-tube voltmeter from common negative (negative side of C2) to the point designated: 960V at hot side of C2, 650V at pin 2 of V2, 500V at pin 3 of V4, 260V at hot side of C101B, 150V at pin 5 of V102, 109V at pin 5 of V103.
4. Set Range switch to each position and see that decimal lights all functions properly.
5. Place instrument on rack to warm up for 8 hours.

TROUBLE. If wattage exceeds 78 watts, shut off unit and check for shorted C1 or C2. Check also resistance from common negative to pin 1 of V4 - should be approximately 100,000 ohms. Resistance from pin 3 of V4 to common negative should be at least 65,000 ohms. Check for shorted pilot lights in meter or shorted tube heaters. Check for shorted C101 in VTVM board. Also check to see that both VR tubes on VTVM board are lit, indicating no short circuits anywhere in VTVM B supply wiring. Check for arcing in the 5Y3 - there must be none after the first few seconds of operation.

3. CHECK Ebb OF MAIN SUPPLY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	920-980V	117V AC

DC Voltage (Ebb) 950V, ±30V
RMS AC Ripple (Ebb) less than 20V

With VTVM set to 1,500V range, read from common negative of 1 mfd - 1,000V DC capacitor (C2) to positive terminal of C2. Should read 950V, plus or minus 30V.

TROUBLE. Indicated trouble will probably lie in the pre-regulator or final regulator circuit. Steps 4 and 7 will indicate which one.

4. CHECK DC OUTPUT OF PRE-REGULATOR

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	620-670V	117V AC

With VTVM set on 1,500V, read from common negative of C2 to pin 2 of V2 (6AQ5); voltage should be 645V, ±25V.

TROUBLE. If voltage is not within tolerance, check first to see if instrument is regulating. With a line voltage change of 100 to 130 volts, output voltage should not vary more than 8 volts. If supply is regulating (as shown by a ripple voltage of less than 150 mv) but output voltage is outside limits, check voltage from pin 5 of V5 to common negative - must be 150V plus or minus 3V. If outside these limits replace V5. Also check R5 and R6 - if off by more than 1%, replace. If supply is not regulating, pull V4 to remove loading effect of final regulator circuit. If trouble clears up, fault is in final regulator circuit. If trouble persists, replace V3 (6AU6) and V2 (6AQ5) in this order. Other things to check are C3 for short circuits or leakage, R2, R3, and R4 and all connections for poor soldering or shorts. Check the printed circuit board for any scratches which might cause an open circuit or a drop of solder which might cause a short circuit.

5. CHECK RIPPLE IN OUTPUT OF PRE-REGULATOR.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	20-150 mv	100-130V

With a RMS AC VTVM, check ripple from pin 2 of V2 to common negative on C2. As line voltage is varied, ripple should change from approximately 25 mv at 130V AC line voltage to no more than 150 mv at 100 V AC line voltage.

TROUBLE. If ripple exceeds 150 mv at 100V AC, change V3 (6AU6). If this does not cure the trouble, refer to TROUBLE Section of step 4.

6. LINE VOLTAGE AT LOSS OF CONTROL.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<100V	100V

Observe ripple as in step 5 as line voltage is lowered below 100V. Loss of regulation as indicated by suddenly increasing ripple must occur below 100 volts. (Hold voltage at 100V for 10 seconds to permit tube heaters to cool.)

TROUBLE. If loss of control occurs above 100 volts AC, replace V3 (6AU6). If this does not help, refer to TROUBLE section of Step 4.

7. CHECK OUTPUT VOLTAGE OF FINAL REGULATOR.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	500V ±6V	117V

With VTVM in 1,500 volt range, measure the output voltage from pin 3 of V4 (12AU7) - should be 500V ±6V. Rotate ADJ CAL knob from one extreme to other and check voltage change. Change must be approximately 3 volts.

TROUBLE. If trouble is present, check for rattle, proper regulation, and output voltage with an 801. Turning P1 (Adj. Cal. pot) and adjusting P6 (5 k Trimit pot) should vary the output voltage over a range of approximately 12 volts. This range should include the 500 volt point. If it does not, check the voltage at pin 5 of V7 - it should be 166V ±3V. If this voltage is out of tolerance, replace V7 and V8 (OG3 tubes). If trouble persists, replace V4 and V6 in that order. Should the output voltage still not reach 500 volts, check R18 (158 k), R17 (320 k) R7 (149 k), R9 and R10 (300 k), and R13 (250 k). If the output voltage still cannot be adjusted to 500 volts, set Range switch to CAL position; this disconnects the range divider and the 5-dial Kelvin-Varley divider from the output. If trouble clears up, determine which divider is faulty.

8. CHECK RIPPLE IN MAIN 500V REFERENCE SUPPLY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	< 8 mv	100-130V

With AC RMS VTVM connected from common negative to pin 3 of V4, vary line voltage from 100 to 130 volts. Ripple should not exceed 8 mv.

TROUBLE. If ripple is too high, replace V3. If trouble still persists, refer to TROUBLE under step 7.

9. CHECK LINE VOLTAGE AT LOSS OF CONTROL.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<100V	100V

Observe ripple as in step 8 as line voltage is lowered below 100 volts. Loss of regulation as indicated by suddenly increasing ripple must occur below 100 volts.

TROUBLE. If loss of control occurs above 100 volts AC, replace 6AU6. If this does not help, refer to TROUBLE section of step 7.

10. CHECK GRID-CATHODE VOLTAGE OF V4A.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	not less than -2V	100V

Set line voltage to 100 volts, turn ADJ CAL knob to maximum counter clockwise position, set VTVM to 5V range and DC (-) polarity. Connect common or ground lead to pin 3 of V4 (this makes case of VTVM 500V hot to chassis of 801 under test - stay clear while making this test) and connect probe to pin 2 of V4. Adjust P6 (5 k Trimit pot) for minimum voltage reading. Bias must not be less than -2.0 volts.

TROUBLE. If bias is less than -2.0 volts, replace V4 (12AU7). Should trouble persist, check R5 (500 k) and R6 (144 k). If off by more than 1%, replace.

11. CHECK STABILITY OF REFERENCE SUPPLY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	< 40 mv	100 - 130V

Set ADJ CAL knob to vertical position and AC line voltage to 100 volts. Adjust P6 (5 k Trimit pot) for an output voltage of 500 as read on a Ⓕ Model 800 or 801. When reference supply output is nulled, run AC line voltage up to 130 volts and, after a short wait for the reference supply to stabilize again, look for meter deflection on 800 or 801 used as a standard. The regulation of the 500 volt supply should be less than 40 mv (2 small scale divisions) and should never exceed 50 mv (2-1/2 small scale divisions). At this point give unit first NWT test - tap chassis several times on all sides and check for erratic output - 500 volts as observed on monitoring 800 or 801 must remain steady except for slight shift of a small division or so caused by minute changes in tube geometry.

TROUBLE. If the regulation is unsatisfactory, replace V6 (12AX7) with an aged tube and recheck. If the regulation is okay, but output voltage rattles or changes erratically, see TROUBLE under step 7. If trouble persists, go to TROUBLE in step 4. If this doesn't cleat trouble, see step 3. Should the trouble still exist, give unit a thorough visual inspection as in step 1 because something was missed.

12. CHECK INTERNAL CALIBRATION SYSTEM (1V SAMPLE).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	About 1V	117V

Connect VTVM from common negative to top of R16 (509 ohms) - voltage should be slightly over one volt. If okay, rotate 5 ohm pot (P2) from one end to other; 1 volt reading should change about 1% smoothly. If there is any sudden change in the 1 volt reading, rotate P2 rapidly several times to clean wiper. If trouble persists, tag unit and send back for new pot. If okay, plug in standard cell, set RANGE switch to CAL position and push button lightly - meter needle should deflect less than 1 large division. If it pins violently, cell is wired to the plug backward. Tag instrument and reject.

TROUBLE. If voltage is not correct, check value of R15 and R19 (125 k). Voltage drop across R15 and R19 should be approximately 249.49 volts each as read on ℱ Model 800 or 801 but must be within 500 mv of each other.

THIS COMPLETES CHECKING OF MAIN BOARD. TURN UNIT AROUND AND PROCEED WITH TESTING OF VTVM BOARD.

13. CHECK DC VOLTAGE ACROSS OUTPUT SECTION OF C101.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	240-270V	117V

Connect VTVM across output section of C101 filter capacitor - should read 255V ±15V.

TROUBLE. If the voltage is low or the ripple high, check each section of C101 by substituting a good 8 mfd capacitor, one section at a time. If C101 is good, check for excessive heating of the three selenium rectifiers RE1, RE2, and RE3 or check by substitution. Also see that V102 (OA2) and V103 (OB2) are glowing.

14. CHECK RIPPLE ACROSS OUTPUT SECTION OF C101.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<2V	117V

With AC RMS VTVM, check ripple at same points as in 13 above. Should be less than 2 volts.

TROUBLE. See TROUBLE under step 13.

15. CHECK DC VOLTAGE ACROSS V102 (OA2).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	145-155V	117V

With VTVM check DC voltage from common negative (positive terminal of B1, mercury bias cell on small board) to pins 1 or 5 of V102 (OA2). Should read 150V ±5V.

TROUBLE. If out of tolerance, replace V102. If trouble persists, refer to TROUBLE in step 13.

16. CHECK RIPPLE ACROSS V102 (OA2).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<80 mv	117V

Using AC RMS VTVM, check ripple from common negative to pins 1 or 5 of V102. Should read less than 80 mv.

TROUBLE. If out of tolerance, replace V102. If trouble persists, refer to TROUBLE in step 13.

17. CHECK DC VOLTAGE ACROSS V103 (OB2).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	105-111V	117V

Using ℱ Model 800 or 801, measure dc voltage from common negative to pins 1 or 5 of V103. Should read 108V ±3V.

TROUBLE. If out of tolerance, replace V103. If trouble persists, refer to TROUBLE in steps 16 and 13.

18. CHECK REGULATION ACROSS V103 (OB2).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	∠60 mv	100-130V

With ℱ Model 801 connected from common negative to pins 1 or 5 of V103, vary AC line voltage from 100 to 130 volts. Output regulation should be less than 60 mv.

TROUBLE. If out of tolerance, replace V103. If trouble persists, refer to TROUBLE in steps 16 and 13.

19. CHECK RIPPLE ACROSS V103.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	∠2 mv	117V

Using AC RMS VTVM, check ripple from common negative to pins 1 or 5 of V103. Should read less than 2 mv.

NOTE: AT THIS VERY LOW RANGE, AC VTVM WILL BE SENSITIVE TO ANY STRAY AC FIELDS SUCH AS MIGHT BE INTRODUCED THROUGH HAND CAPACITY. TRY TO KEEP HANDS CLEAR OF PROBE DURING CHECK.

TROUBLE. If out of tolerance, use a probe with an alligator clip on it to make contact while hands are removed from vicinity of probe. If trouble persists, replace V103. Should trouble continue, see TROUBLE under steps 13 and 16.

20. CHECK REGULATION OF HEATER AND CHOPPER VOLTAGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<.8V	105-130V

Using an AC RMS VTVM, read filament voltage across P102 (.1V - .01V ZERO) at 130V AC line voltage. Then reduce line voltage to 105V, wait a short period for the 9-7 ballast tube to restabilize the filament voltage, and read the voltage across P102 again. The difference between the first and second voltage readings must not exceed .8V. The filament voltage at all times must be 6V ±.7V.

In a rack mounted 801, read the filament voltage across R103 (56 ohms) instead of across P102 since this pot will be difficult to get at.

TROUBLE. If the regulation is more than .8V or the filament voltage is out of tolerance, replace 9-7 ballast tube. If trouble persists, check voltage from filament winding on power transformer - should be about 15 volts at 117 volts line.

21. CHECK V104 (12AU7 OR 7316) FOR GRID CURRENT.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
.5V	VTVM	000.00	<1/2 small scale division	117V

Zero meter with P101 (10V - 1V ZERO), then short the input binding posts, being sure to connect the shorting bar to the minus (-) terminal first. Observe closely for movement of the meter pointer to the left. Must not exceed 1/2 of one small scale division. Repeat test several times for safety.

TROUBLE. If grid current is excessive, replace V104 with an aged tube. Then repeat tests 20 and 21.

22. CHECK STABILITY OF VTVM TUBE, V104 (12AU7 OR 7316).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	000.00	<40 mv	105-130V

Set AC line voltage to 105, wait a few moments for voltages to stabilize, and adjust P101 (10V - 1V ZERO) for zero on the meter. Raise AC line voltage to 130, and see that after the needle has stopped moving, it is within 40 mv (2 small scale divisions) of zero. When meter is zeroed, pointer on P101 must be vertical, plus or minus 90 degrees.

TROUBLE. If offset of needle is excessive, replace V104 with an aged tube, either a 12AU7 or 7316.

23. ADJUST VTVM METER SENSITIVITY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<1-1/2 small scale divisions	117V

Zero meter with P101 (10V - 1V ZERO), apply an accurate 500V DC to input terminals of 801 under test, and adjust P104 for full right scale deflection. Remove voltage, recheck zero, then apply voltage with polarity reversed. Needle should be within 1-1/2 small divisions of end scale. If meter reads in excess of 1-1/2 small divisions reverse input again and adjust P104 slightly to split the error - that is, if meter reads 2 small divisions to the left of full scale on the left hand side, adjust P104 to cause meter to read about 1/2 small division to the right of zero on the right hand side. This will reduce error on left side to approximately 1-1/2 small division.

TROUBLE. If pointer comes to rest more than plus or minus 2 small scale divisions from left end of scale, replace V104 and repeat steps 20, 21, 22, and 23. If this does not cure or reduce the error, replace the meter.

24. CHECK METER STICKINESS.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<1/2 small scale division	117V

In step 23 check for meter stickiness as follows: When meter pointer has come to rest after applying or removing a voltage lightly tap meter and observe closely any movement of pointer. Movement must be less than 1/2 of one small scale division.

TROUBLE. If stickiness exceeds 1/2 of one small scale division, replace the meter.

25. CHECK METER LINEARITY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<1-1/2 small scale divisions	117V

Apply an accurate 500 volts to input terminals of 801 under test. Reduce input voltage in steps of 100 volts. Linearity of meter at 100 volt steps must be less than 1-1/2 small scale divisions. Reverse polarity of input voltage and work out to other end of scale, again in 100 volt steps. At this point check for NWT. Tap chassis on all sides with meter reading 300 volts and check for needle flop - meter reading must vary no more than 1 small division total. If any wobble or erratic action noted check for poor soldering on NULL and RANGE switches.

TROUBLE. If linearity exceeds 1-1/2 small scale divisions, replace meter, then repeat steps 20 to 24.

26. CHECK FULL SCALE ACCURACY OF VTVM IN 50V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	VTVM	000.00	<2 small scale divisions	117V

Apply an accurate 50 volts to input terminals of 801 under test. End scale error total must not exceed 2 small divisions at either end, with total allowable error being 3 small divisions.

TROUBLE. If total end scale error is out of tolerance, check resistors R136 through R139. One or more are out of tolerance or miswired.

27. CHECK FULL SCALE ACCURACY OF VTVM IN 5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	VTVM	000.00	<2 small scale divisions	117V

Apply an accurate 5 volts to input terminals of 801 under test. End scale error total must not exceed 2 small divisions at either end, with total allowable error being 3 small divisions.

TROUBLE. See TROUBLE under step 26.

28. CHECK FULL SCALE ACCURACY OF VTVM IN .5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
.5V	VTVM	000.00	<2 small scale divisions	117V

Apply an accurate .5V to input terminals of 801 under test. End scale error total must not exceed 2 small divisions at either end, with total allowable error being 3 small divisions.

TROUBLE. See TROUBLE under step 26.

29. CHECK FOR LEAKAGE FROM GRID OF VTVM.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	000.00	<1/4 small scale division	117V

Zero meter with P101 (10V - 1V ZERO). Rotate dial "A" from 0 to 4, dial "B" from 0 to 9, and check for needle offset to left. Movement must not exceed 1/4 of one small scale division.

TROUBLE. If meter offset due to leakage is excessive, it will be necessary to wash certain components. The red PLUS input post should be washed ONLY in denatured alcohol, as it is soluble in petroleum base solvents. The ceramic NULL switch, the three ceramic posts and the two ceramic-shell capacitors on the VTVM board must be washed in Metriclene Solvent M4 and re-coated with a dilute solution of silicone fluid (1 part Dow Corning DC-200, viscosity grade 100, to 10 parts by volume of Metriclene M4).

In trouble-shooting older models of the 801, the grid input leads may be of ordinary hookup wire and may require replacement with special low-leakage Teflon wire.

30. CHECK LINEARITY OF KELVIN-VARLEY VOLTAGE DIVIDER BY COMPARISON WITH
31. ESI DECADE VOLTAGE DIVIDER (SPECIAL HIGH ACCURACY DIVIDER - ESI MODEL X376).

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	499.9 10	<.01%	117V

Zero meter of 801 under test. Set dials on ESI Decade Voltage Divider to 499.99 10 and dials on 801 to 499.9 10. Connect the test lead from COMMON at input of ESI D. V. D. to common negative on reference supply board. Connect the test lead from 500V input on ESI D. V. D. to pin 3 of V4 (12AU7) on reference supply board. Connect OUTPUT (positive) and COMMON (negative) to input of 801. As output of ESI D. V. D. is plugged into 801, a slight offset of the meter may be noted. If it exceeds 1/4 of one small scale division, repeat step 21. If offset is less than 1/4 of one small scale division, proceed with test but subtract error due to grid current before determining error present in Kelvin-Varley.

1. Turn NULL to VTVM, ESI D. V. D. to 399.99 10, and 801 to 399.9 10. NULL switch must be in VTVM position during changes of voltage to prevent pinning the meter.

2. Return NULL to 1V position; needle should be within 40 mv of zero (.01% of 400 volts).

3. Repeat above procedure for 299.9 10, 199.9 10, and 099.9 10 volts. Error must not exceed 30 mv, 20 mv, and 10 mv respectively.

4. Repeat above procedure with the "B" switch, turning it down in 10 volt steps, and returning NULL to VTVM before each voltage change. Error at 009.9 10 must not exceed 5 mv.

5. Repeat above procedure for the remaining switches, "C", "D", and "E". Error for these steps must not exceed 5 mv.

At this point, check for NWT again while measuring 300 volts in 1 volt null range. Tap chassis on all sides and watch meter closely - needle should not shift more than 1 small scale division either way. If bad rattle or other erratic action noted check Kelvin-Varley switches for poor soldering or intermittent shorts.

TROUBLE. Poor correspondence is caused by one of two things, an out-of-tolerance resistor on one of the five switches or contaminated switch wafers. Since ABSOLUTELY NO CORROSIVE FLUX is allowed in the soldering of resistors to these switches it is almost certainly a defective resistor. Usually error will increase gradually up to a point and then fall off abruptly as voltage dials are rotated. The defective resistor will usually be found at this point. If error is very large the defective resistor can be found with an ohmmeter. Otherwise use a model 801 to measure the voltage drops across each resistor on the switch in question. The defective resistor is very easily detected in this manner.

There is always the possibility of a short circuit in the Kelvin-Varley. With all five dials at zero, dial up slowly while watching the OG3 regulator tubes in the reference supply. If they start to dim, quickly turn instrument off and give K-V a thorough visual inspection. Look for small metal hairs that might cause trouble, also look for loose drops of solder, and excessive solder on switch contacts that might spread enough to touch one of the long screws holding the switch wafers together. Look for any unclipped lead-ends that might cause a short circuit. After the short has been cleared, replace the 12AU7 in the reference supply since, if the instrument was operated with the short circuit present, the series-passing tube (12AU7) was almost surely overloaded. If not replaced, this tube would cause erratic changes in the output voltage from the reference supply.

If the trouble does not seem to be either a short circuit or a defective resistor, check for mis-wiring, preferably by checking against an 801 known to be operating correctly.

32. CORRESPONDENCE TO STANDARD AT 100.00V.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	100.00	<10 mv	117V

Set ESI Decade Voltage Divider to 099.99 10, 801 to 100.00, RANGE to 500V and NULL to 1V. Connect as in step 30. Error should be less than 10 mv (1/2 of one small scale division). Now set 801 dials to 099.9 10 and recheck correspondence. Error must be less than 10 mv.

TROUBLE. See TROUBLE under section 30.

33. CHECK ACCURACY OF 1V AND 10V NULL RANGES.

34.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	255.00	<3 small scale divisions	117V

Set ESI Decade Voltage Divider to 255.000 and 801 to 255.00. Connect as in step 30. Turn "C" dial from 5 to 6, and from 5 to 4. Total error must not exceed 3 small scale divisions and end scale error at either end must not exceed 2 small scale divisions. Reset "C" to 5 and turn NULL to 10V range. Rotate "B" dial from 5 to 6, and from 5 to 4. Total error must not exceed 3 small scale dividions and end scale error at either end must not exceed 2 small scale divisions.

TROUBLE. If total error or end scale error is excessive, check resistors R128 (4.5 megohm), R129 (500,000 ohms), and R132 (4.99 megohms). If off by more than 1%, replace.

35. AT THIS POINT SLIP INSTRUMENT INTO CASE. (Unshielded chopper amplifier is affected by stray fields.)

36. CHECK OFFSET BETWEEN .1V AND .01V NULL RANGES.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	1V	00.000	<1/4 small scale division	117V

Zero meter with NULL switch in 1V range, then turn to .01V range and zero again, this time with the .1V - .01V ZERO. Now turn NULL switch to .1V position. Meter offset must not exceed 1/4 of one small scale division.

TROUBLE. If offset exceeds 1/4 of one small scale division, refer to step 29 under TROUBLE. If this does not improve the situation, check the leads to the input of the chopper. These leads should be of Teflon insulated wire which has very low leakage charateristics. In trouble-shooting older models of 801, these chopper input leads may be of ordinary hookup wire and may require replacement with the special low-leakage wire.

37. CHECK LEAKAGE RESISTANCE IN CHOPPER AMPLIFIER CIRCUITRY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	1V	00.000	<1/4 small scale division	117V

Zero meter in 1V NULL range, then switch to .01V NULL. Zero meter again, and set "A" dial to 4. Meter must not offset more than 1/4 of one small scale division.

TROUBLE. If offset due to leakage resistance exceeds 1/4 of one small scale division, refer to step 29 under TROUBLE.

38. CHECK STABILITY OF .01V RANGE AGAINST METER ZERO.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	1V	00.000	<2 small scale divisions	105-130V

With NULL switch in 1V position, zero meter with P101 (10V - 1V ZERO). Switch NULL to .01V position and zero again, this time with P102 (.1V - .01V ZERO). Run Line voltage up to 130V and observe movement of meter. When needle comes to rest, it must be within 2 small scale divisions of zero. Pointer on P102 must be within 90° of vertical.

TROUBLE. If needle offset exceeds 2 small divisions after it has stopped moving, replace V100 (12AX7). If this does not bring the stability within tolerance, replace V104 (12AU7 or 7316), and repeat steps 21, 22, and 23.

39. SET CHOPPER AMPLIFIER GAIN.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	1V	0.0000	-	117V

With NULL at 1V, zero meter. Connect a 39,000 ohm resistor across 801 input terminals and switch to .01V NULL range. Zero meter again and set "C" dial to 1. Draw 801 out of its case just far enough to allow access to the lower screwdriver adjust pot on the VTVM board. Adjust P103 (the screwdriver adjust pot) for exactly one small scale division less than left full scale deflection on meter. Then remove 39,000 ohm resistor.

TROUBLE. If unable to zero meter in .01V NULL range, check V100 (12AX7) and V105 (6C4). Also check chopper. If this doesn't help, check for defective components and miswiring. If unable to set needle to one small division less than end scale deflection, see above tests. In checking chopper amplifier circuit, an oscilloscope may be necessary. The chopper amplifier gain is set so that a 10 millivolt DC signal applied to the top of R123 and the common of the VTVM channel will produce 500 millivolts of DC across C103.

40. CHECK THE THREE RANGE POTS FOR NOISE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	499.9 10	-	117V

Zero meter, apply 500 volts to input terminals of the 801 and trim ADJ CAL for zero on meter. Remove voltage, set RANGE switch to 50V, and apply 50 volts

to 801 input terminals. On rack mounted 801, the location of the 50V, 5V, and .5V range pots is just opposite of the standard 801. Left is .5V, middle is 5V, and right is 50V. Using screwdriver, turn left hand 600 ohm rheostat on the range resistor board through its entire rotation, observing meter closely. Set needle approximately to zero with screwdriver, set NULL to .1V range, and again rotate rheostat. Set near zero, set NULL to .01V range and rotate rheostat. In all NULL ranges, meter must not jump but move smoothly as slider is rotated through its range.

Repeat procedure for 5V and .5V range by applying 5 volts and .5 volts respectively to 801 under test.

TROUBLE. If, during the rotation of any rheostat, the meter jumps suddenly, rotate the rheostat several times as the contacts inside the rheostat may be dirty. If this does not cure the jumping, replace the rheostat.

If, during the rotation of any rheostat, the meter cannot be zeroed, first check the voltage of the 500 volt reference supply. If this is all right, check the voltage being applied to the 801. If unable to zero meter in 50V, 5V, and .5V ranges, trouble is probably in one of the 112,375 ohm resistors common to these three ranges. The drop across these resistors should be approximately 224 volts and should lie within 250 mv of each other. If the voltage drop across these two resistors differs by more than 250 mv, replace the resistor showing the lower voltage. If unable to zero the meter in any one of the three lower voltages ranges the trouble lies in R144 in the case of the 50 volt range, R145 or R147 in the case of the 5V range, or R146 or R148 in the case of .5V range.

41. CHECK INTERNAL CALIBRATION SYSTEM.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
CAL	VTVM	000.00	0	117V

First, set reference supply to an accurate 500 volts. With RANGE switch in CAL position push CAL button momentarily. Meter should deflect somewhere within one large scale division of zero. Press CAL button and, with an insulated screwdriver, turn P2 through its entire range and watch for any sudden movements of the meter. Needle should pass through zero. Adjust meter so that there is no perceptible movement when CAL button is pressed. With CAL button released, check meter and adjust by means of screw on meter case if necessary.

TROUBLE, Check wiring of standard cell plug and CAL button. If trouble persists, refer to TROUBLE in step 12.

42. CHECK KNOB POSITION OF 10V - 1V ZERO ADJUST.

43. CHECK KNOB POSITION OF .1V - .01V ZERO ADJUST.

44. CHECK KNOB POSITION OF ADJ CAL ZERO ADJUST.

Sketch in the position of the pointers on these three knobs on the test sheet for the 801 being tested. All pointers should be within 90 degrees of vertical which is mid-range on all three pots.

CALIBRATION OF 801

This consists of two parts - a "hot" check and a "cold" check. The hot check is made after the instrument has had at least 32 hours ageing time and not less than 3 hours of warm-up time in the case. The cold check is made after unit has operated for one-half hour after having cooled for at least 3 hours. The purpose of these two checks is to show up any resistors with abnormally high temperature coefficients of resistance or standard cells with excessive hysteresis. The unit is calibrated "hot".

A. ADJUSTMENT OF VTVM METER SENSITIVITY.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	VTVM	000.00	<6%	117V

Zero meter with P101 (10V - 1V ZERO), apply an accurate 500V DC to input terminals of 801 under test, and adjust P104 for full right scale deflection. Remove voltage, recheck zero, then apply voltage with polarity reversed. Needle should be within 1-1/2 small scale divisions of end scale, either left or right. Total error must not exceed 3 small scale divisions overall.

TROUBLE. Refer to TROUBLE in step 23.

B. SET CHOPPER AMPLIFIER GAIN.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	1V	0.0000	-	117V

With NULL at 1V, zero meter. Connect a 39,000 ohm resistor across 801 input terminals and switch to .01V NULL range. Zero meter again and set "C" dial to 1. Draw 801 out of its case just far enough to allow access to the lower screwdriver adjust pot on the VTVM board. Adjust P103 (the screwdriver adjust pot) for exactly one small scale division less than left full scale deflection on meter as this determines the accuracy of the chopper amplifier.

TROUBLE. Refer to TROUBLE in step 39.

C. CALIBRATE 500V REFERENCE SUPPLY AGAINST INTERNAL STANDARD CELL.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	1V	499.9 10	<20 mv	117V

Set voltage standard (ESI, X194 box) to 500V and adjust output of 301E to exactly 500 volts as indicated by the L and N galvo. Carefully zero meter and connect to input of 801 under test and adjust the ADJ CAL knob until meter reads exactly zero. Turn RANGE switch to CAL position and momentarily press CAL button. With an insulated screwdriver adjust P2, the 5 ohm rheostat, until absolutely no meter needle movement is noted when CAL button is pressed and released. It is extremely important that this operation be very carefully performed since it determines in large part the overall accuracy of the instrument in all 4 ranges. Switch back to 500V position and recheck nulling with 500V input from voltage standard. If still within plus or minus 1 small scale division (20 mv) apply a drop of cement to P2.

TROUBLE. Refer to TROUBLE in step 7. Sometimes, when RANGE switch is turned from 500V to CAL and back again, an offset of as much as 40 mv may be noticed. If this occurs, replace the OA2 in the reference supply.

NOTE: Before doing each of the following steps, adjust the reference supply to 500V by nulling against an accurate 500V standard with the ADJ CAL knob.

D. CHECK ACCURACY OF INSTRUMENT READING AT 50 VOLTS IN THE 500 VOLT RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
500V	.01V	49.9 10	<10 mv	117V

Set voltage standard to 50 volts and apply to input of 801 under test. Turn NULL switch to .01V range and note error in millivolts together with its sign (plus if needle deflects to right and minus if to left). Error should not exceed 7 mv and never more than 10 mv (.02%).

E. Set NULL switch to VTVM and Kelvin Varley to 50.00; null to .01V. Error should not exceed 10 mv (.02%).

TROUBLE. If error is greater than .02%, recheck linearity of Kelvin-Varley voltage divider as in step 30.

F. CALIBRATE 50V RANGE POT.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	1V	49.99 10	0	117V

Zero meter in 1V NULL range, switch down to .1V NULL range and zero again. Set ESI standard to 50V and connect to input terminals of 801. Using an insulated screwdriver, adjust left hand 600 ohm rheostat on plexiglass board at top of instrument for meter zero. Set NULL to .01V range and adjust rheostat for exactly zero. Apply cement to P3.

TROUBLE. If unable to zero meter, see TROUBLE in step 40. If meter rattle is noted in excess of 5 mv (.001%), first unplug input voltage and check by watching galvo for erratic output from 301E. If this is not the trouble, check the 801 under test without an input voltage for rattle in the .01V meter circuit. Replace V100 (12AX7) and V103 (OB2) in this order if necessary. If trouble persists, check the reference supply for rattle. If rattle appears in output of reference supply, refer to TROUBLE under step 7.

G. CHECK ACCURACY OF INSTRUMENT READING AT 5 VOLTS IN THE 50V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	.01V	4.99 10	<1 mv	117V

Set voltage standard to 5 volts and apply to input of 801 under test. Note error in tenths of millivolts. Error should be less than .7 mv and at no time more than 1 mv.

H. Set NULL switch to VTVM and Kelvin-Varley to 5.000; null to .01V. Error should not exceed above limits.

TROUBLE. If error exceeds specified limits, see TROUBLE in sections D and F.

I. CALIBRATE 5 VOLT RANGE POT.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.1V	4.999 10	-	117V

Set voltage standard (ESI box) to 5 volts, and apply to input of 801 under test. Turn NULL switch to .01V range and, using an insulated screwdriver, adjust center 600 ohm rheostat for .7 mv. It has been found through experience that by setting the 5V range to .7 mv a better overall accuracy will be obtained for the 5V range. Apply a drop of cement to P4 to seal it.

TROUBLE. If unable to zero meter, see TROUBLE in section F.

J. CHECK ACCURACY OF INSTRUMENT READING AT . 5 VOLTS IN 5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.01V	. 499 10	<. 2 mv	117V

Set voltage standard to .5 volts and apply to input of 801 under test. Note error in tenths of millivolts. Error should be less than .1 mv and at no time more than .2 mv.

TROUBLE. If error exceeds specified limits, see TROUBLE in sections D and F.

K. CALIBRATE .5 VOLT RANGE POT.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
.5V	.01V	.4999 10	0	117V

Set voltage standard to .5 volts. Apply to input of 801. Using an insulated screwdriver, adjust right hand 600 ohm pot for exact zero on meter. Apply a drop of cement to P5 to seal it.

TROUBLE. If unable to zero meter, see TROUBLE under section F.

NOTE: The following checks will be made with a special voltage standard, utilizing a mercury cell and a standard cell by reading the sum and difference voltages of these two cells as well as their individual voltages. HAVE BOTH CELLS CHECKED ON THE "K" POT FOR TRUE EMF BEFORE USING.

L. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF STANDARD CELL IN 5V RANGE. (Following Kelvin-Varley settings are approximations.)

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.01V	1.0194	<.03%	117V

Set switch on special voltage standard to STD CELL and connect to input of 801 under test. Adjust K-V for null. Total error must not exceed .03% of "K" pot reading for standard cell.

TROUBLE. If error exceeds .03% check K-V for linearity. If K-V is okay and reading is high, check C111 (1 mfd, 200V polystyrene capacitor) for proper operation in its circuit. If K-V reading is low, check transformer for leakage.

M. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF MERCURY CELL IN 5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.01V	1.3437	<.03%	117V

Set switch on special voltage standard to MERC. CELL and connect to input of 801 under test. Adjust K-V for null. Total error must not exceed .03% of "K" pot reading for mercury cell.

TROUBLE. If error exceeds .03%, see TROUBLE under section L.

N. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF MERCURY CELL MINUS EMF OF STANDARD CELL IN 5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.01V	0.3243	<.03%	117V

Set switch on special voltage standard to DIFF. and connect to input of 801 under test. Adjust K-V for null. Total error must not exceed .03% of difference of "K" pot readings for mercury cell and standard cell.

TROUBLE. If error exceeds .03%, see TROUBLE under section L.

O. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF MERCURY CELL PLUS EMF OF STANDARD CELL IN 5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
5V	.01V	2.3631	<.03%	117V

Set switch on special voltage standard to SUM and connect to input of 801 under test. Adjust K-V for null. Total error must not exceed .03% of sum of "K" pot readings for mercury cell and standard cell. At this point check again for NWT. Tap instrument with palm of hand on all sides watching meter closely for wobble or jumps in excess of 1 small scale division. If trouble noted, check chopper amplifier and null switch wiring for poor soldering.

TROUBLE. If error exceeds .03%, see TROUBLE under section L.

P. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF MERCURY CELL MINUS EMF OF STANDARD CELL IN .5V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
.5V	.01V	.3244	<.03%	117V

Set switch on special voltage standard to DIFF. and connect to input of 801 under test. Adjust K-V for null. Total error must not exceed .03% of difference of "K" pot readings for mercury cell and standard cell.

TROUBLE. If error exceeds .03%, see TROUBLE under section L. A low reading here often indicates transformer or wire harness leakage.

Q. CHECK ACCURACY OF INSTRUMENT BY READING EMF OF STANDARD CELL IN 50V RANGE.

RANGE SW.	NULL SW.	K. V.	TOLERANCE	LINE VOLTAGE
50V	.01V	01.019	<.03%	117V

Set switch on special voltage standard to STD. CELL and connect to input of 801 under test. Adjust K-V for null. In reading standard cell in 50V range, the fifth digit will be read on meter and must be within .03% of "K" pot reading of standard cell. Also it should correspond to standard cell reading taken in 5V range.

TROUBLE. If error exceeds .03%, see TROUBLE under section L.

"COLD" CALIBRATION CHECK.

When the instrument under test has been off for at least three hours, it is ready for "cold" calibration. After instrument has been on for 20 to 30 minutes (from a completely cold condition), repeat steps A through N. If any calibration error exceeds .01%, split it. For example, in step A, if meter reads to the right 100 mv (.02%) with 500 volts input from the voltage standard (after careful calibration using CAL button and ADJ CAL knob), proceed as follows: Turn ADJ CAL knob until meter reads to the right 50 mv (.01%) and re-set the 5 ohm rheostat P2. This splits the error (which may be due to slightly high standard cell temperature coefficient, voltage hysteresis, high or opposite sign resistance temperature coefficiency, or any combination of these effects) so that it lies within .01% both hot and cold. If error exceeds .02%, notify foreman of test or engineering department.

PREPARE INSTRUMENT FOR SHIPPING (BUTTONING UP).

When the instrument has passed both hot and cold checks, it is ready to be buttoned up for shipping. First, give it a visual inspection for loose tubes, nuts, bolts, knobs, dial plates, and switches. Check for rubbing dial plates, binding switches, and any engraving which might have been overlooked. Using a rubber stamp and ink pad, print "2 AMP" on rear of instrument between fuse holder and line cord.

Now the instrument is ready to be sprayed. When doing this, hold a piece of cardboard over all switches so as not to get any plastic spray on the contacts. Also be careful not to spray the 5 ohm pot on the reference supply board as it will become erratic due to poor contact. The instrument is now ready to be placed in its case.

Check the rubber feet on the case to be sure they are on tight, then place instrument in the case. Place a #10-32 x 1" Phillips head screw in the lower hole on the rear of the case. Take another screw of the same type, place a plastic clamp for the line cord on it, then place screw in top hole on rear of case and tighten.

The instrument is now ready for shipping.

MODEL 801

TUBE VOLTAGE CHART

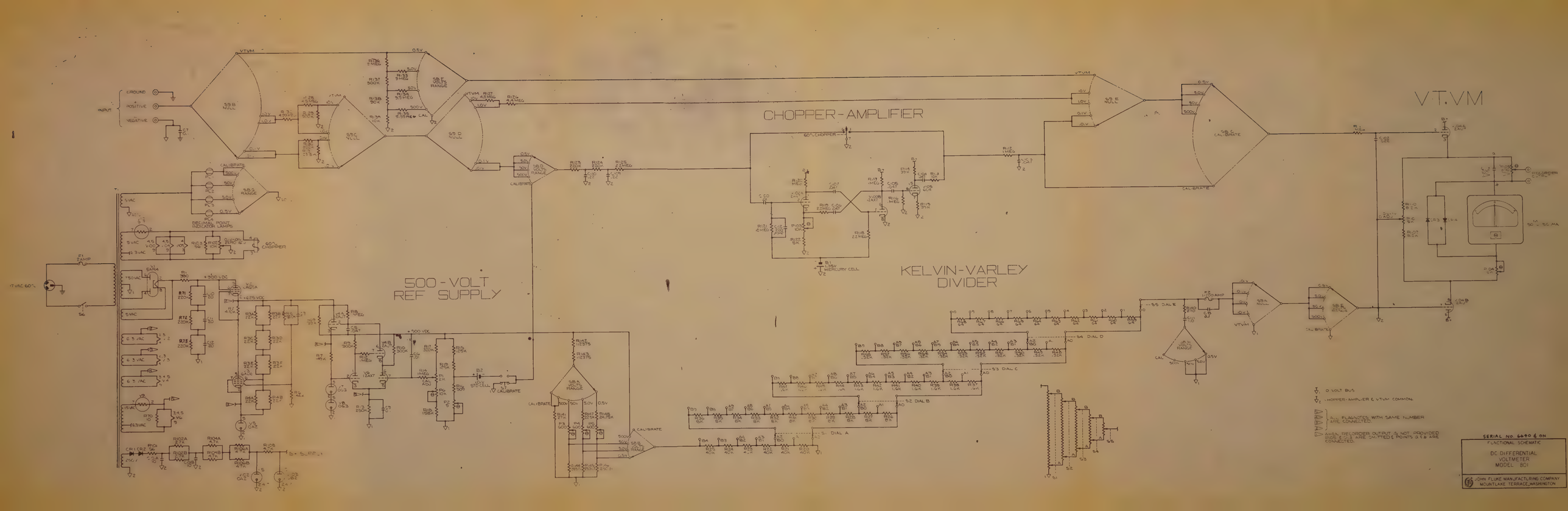
Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V1, 5Y3GT	0	1000	0	a-c 800	0	a-c 800	0	1000	-
V2, 6AQ5A	620	660	660	660	1000	1000	630	-	-
V3, 6AU6	146	150	150	150	630	280	150	-	-
V4, 12AU7	660	500	500	500	500	500	400	420	500
V5, OA2	150	0	0	0	150	0	0	-	-
V6, 12AX7	420	170	170	170	170	410	165	170	170
V7, OG3	170	85	170	0	170	22	85	-	-
V8, OG3	85	0	85	0	85	3.6	0	-	-
V100, 12AX7	85	-0.71	0.15	a-c 6.3	a-c 6.3	82	-1.13	0	a-c 6.3
V101, 9-7	108	0	0	0	0	108	0	-	-
V102, OA2	150	0	0	0	150	0	0	-	-
V103, OB2	108	0	0	0	108	0	0	-	-
V104, 12AU7	108	0	6	a-c 6.3	a-c 6.3	108	0	6	a-c 6.3
V105, 6C4	101	0	a-c 6.3	a-c 6.3	100	0	6.3	-	-

CONDITIONS:

1. Range switch set to 500V D-C.
2. Null switch set to VTVM.
3. Line voltage at 117V, 60 cycles.
4. All measurements made from negative binding post to specified terminal.
5. All measurements made with a VTVM.
6. All voltage dials set to zero.
7. Zero adjust pots counter-clockwise.

MODEL 801 CALIBRATION REPORT

SERIAL NUMBER												
A. VTVM Adjust												
B. Chopper gain												
C. CAL error - 500V												
D. Reading error - 49.9V												
E. Reading error - 50.0V												
F. CAL error - 49.9V												
G. Reading error - 4.99V												
H. Reading error - 5.00V												
I. CAL error - 4.99V												
J. Reading error - .499V												
K. CAL error - .499V												
L. E std. cell - 5V range												
M. E Hg cell - 5V range												
N. Hg - std. cell - 5V range												
O. Hg + std. cell - 5V range												
P. Hg - std. cell -.5V range												
Q. E std. cell - 50V range												

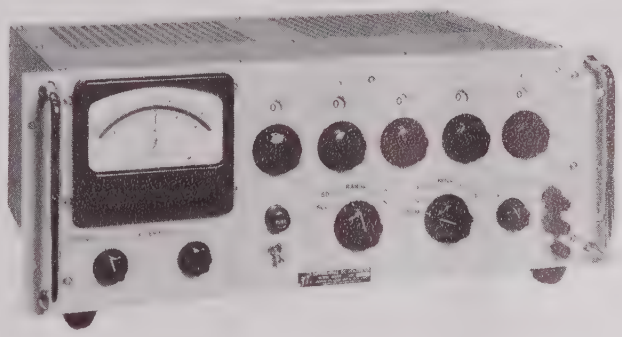

CHOPPER-AMPLIFIER
KELVIN-VARLEY DIVIDER
500-VOLT REF SUPPLY
V.T.VM
SERIAL NO. 6490 & ON
FUNCTIONAL SCHEMATIC
DC DIFFERENTIAL VOLTMETER
MODEL 801
JOHN FLUKE MANUFACTURING COMPANY
MOUNTLAKE TERRACE, WASHINGTON

FLUKE

TECHNICAL DATA

801B VOLTMETER

MODEL 801B PRECISION DC DIFFERENTIAL VOLTMETER



DESCRIPTION

The Model 801B is a sensitive, accurate differential voltmeter with a basic input range of 0 to 500 volts DC. It is self-contained, portable, and virtually impossible to damage by accidental overload. The value of the unknown voltage being measured is presented on a five-decade digital readout with illuminated decimal point. Circuit loading problems are eliminated as this unit has infinite input resistance at null for all voltage measurements up to 500 volts.

The basic elements of the 801B are a standard cell, a stable 500 volt reference source, a precision five-dial Kelvin-Varley voltage divider and a chopper stabilized null detector.

In order to set the reference voltage with high accuracy, the standard cell comparison circuit is factory-set precisely to the actual standard cell voltage available in each instrument. This procedure eliminates resistor tolerances in the comparison circuit. The same approach is used in the decade divider resulting in these strings having a calibration accuracy of better than 0.01%. Resistors on the five Kelvin-Varley dials are matched to each other and, in turn, the completed dials are matched units. The chopper-stabilized null detector in the Model 801B has exceptionally high stability allowing true null to be determined accurately. This stability plus the four ranges of the detector further insures accuracy and ease of operation.

FEATURES

- Accuracy 0.05% of input voltage from 0.1 to 500 volts
- Recorder Output
- Infinite input resistance at null over the entire 500 volt range
- Polarity Switch
- No zero controls
- Taut-band Suspension Meter
- Standard cell reference
- Automatic lighted decimal for fast, direct digital read-out

NOTE THE MANY USES OF THE MODEL 801B

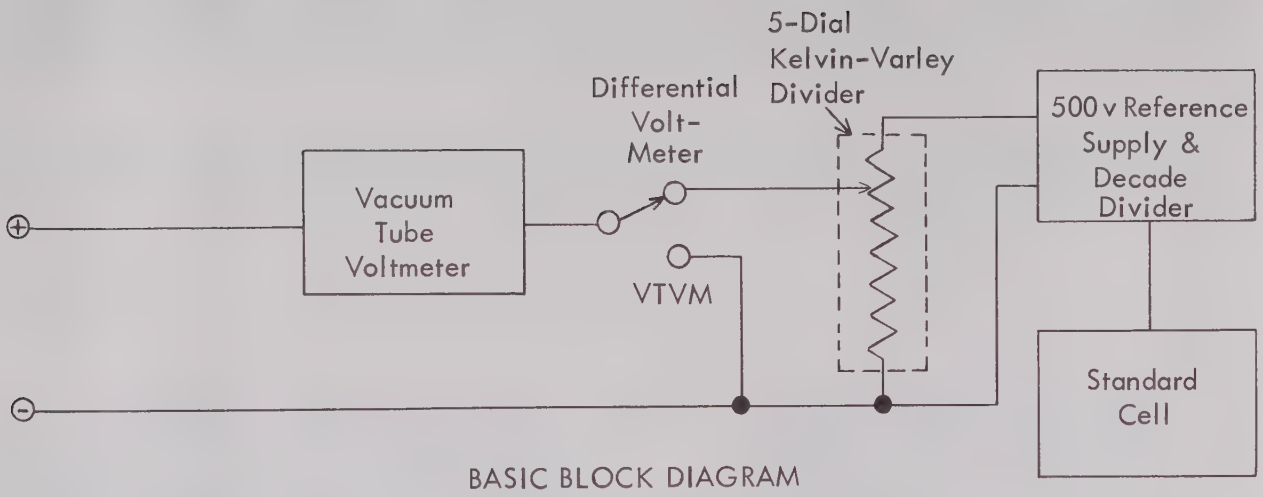
Calibration, testing and stability measurements of regulated power supplies.

Instrument calibration.

DC voltage measurements in high resistance circuits as well as low resistance sources including photocells, standard cells, computers, power supplies, batteries, tube circuits, thermocouples, storage devices, etc.

As a substitute for conventional potentiometers, particularly for voltages above 1.6 v where the loading effect of voltage attenuators cannot be tolerated.

Precise voltage measurements to 30,000 volts may be made with the Model 801B by using the FLUKE Model 80 Series accessory volt boxes.



BASIC BLOCK DIAGRAM

SPECIFICATIONS

AS A PRECISION POTENTIOMETER

RANGES:

Input Voltage Range	*Null Voltage Ranges	Input Resistance per volt of input voltage At Null	1% Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	"	1000 Meg
5-50	1-0-1	"	1000 Meg
	0.1-0-0.1	"	10000 Meg
0.5-5	0.1-0-0.1	"	10000 Meg
	0.01-0-0.01	"	10000 Meg
0-0.5	0.1-0-0.1	"	10000 Meg
	0.01-0-0.01	"	10000 Meg

*Any null range may be used with any input voltage range; recommended ranges are shown above.

ACCURACY: ±0.05% of input voltage from 0.1 v to 500 v ±0.05% ±50 microvolt below 0.1 v.

RESOLUTION:

Input Voltage Range	Dial Limits Volts	Meter Limits on Recommended Null Range Volts
50-500	0.01	0.005
5-50	0.001	0.0005
0.5-5	0.0001	0.00005
0-0.5	0.00001	0.00005

AS A VACUUM TUBE VOLTMETER

VOLTAGE RANGES:
±500, ±50, ±5, ±0.5 and ±10*, ±1*, ±0.1*, ±0.01* volts DC full-scale.
*These ranges obtained by setting null range to desired sensitivity and five voltage dials to zero.

ACCURACY: 3% on all ranges.

INPUT RESISTANCE:
50 megohms for 500, 50, 5 and 0.5 ranges. 10 megohms for 10, 1, 0.1 ranges. 1 megohm for 0.01 range.

GENERAL FEATURES

STABILITY OF REFERENCE:
±0.01% for ±10% change in line voltage (105 - 130 v).
±0.01% per hour after 30 minute warmup.

SETABILITY OF REFERENCE:
Reference supply can be set to 500 volts.
±0.01% or better against built-in standard cell.

STABILITY OF METER READING:
1% of full-scale for ±10% change in line voltage (105 - 130 v).

INPUT POWER:
117 volts, 50 - 60 cycle.

DIMENSIONS:
Cabinet Model - 13" high, 9-3/4" wide, 14" deep.
Rack Model - 7" high, 19" wide, 14" deep.

WEIGHT:
Cabinet Model - 24 lbs.
Rack Model - 21-1/2 lbs.

PRICE:
Cabinet Model - $485.00; Rack Model - $505.00.
All prices f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

7-31-61-A

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Electronics FOR INDUSTRY

FLUKE
JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 801B TEST PROCEDURE

NOTE: The OG3 reference tube must be aged for at least 150 hours before installation in the 801B.

TURN ON

VISUAL INSPECTION

1. Important: Mechanically zero meter.

2. Leakage Resistance - Measure resistance between negative binding post and chassis. Must be infinite as read on a Simpson meter. Set RANGE switch to 500V, NULL switch to VTVM, and K-V dials to 0, Polarity switch to +.

3. Input Power - Set power variac to 0 and turn instrument on. Slowly increase variac setting while monitoring input power. Increase variac setting to 117V. Input power should be 40-65W. Monitor input power while continuing preliminary checks and be alert for smoke or other evidence of trouble. Increase variac setting to 130V and check for any failure. Input power should not exceed 65W (or 75 W for the 801/G). Return variac to 117V for remaining checks.

4. Voltage Measurements (With Respect to Negative Binding Post as 117V Line) -
Reference Supply - High Voltage, Ebb, voltage at pins 7 and 9 of V102 should be 680-730V dc.

5. 500V Reference - Voltage at pin 3 of V102 should be 470-530V, dc.

VTVM Supplies:

6. Voltage at pin 5 of V204 should be 140-168V.

7. Observe if VTVM filaments are lit.

8. Bake - Operate instrument on normal line voltage for not less than 24 hours.

PRE-CALIBRATION CHECKS

NOTE: All measurements are with respect to negative binding post unless otherwise stated and in the positive polarity. Start each check with normal line voltage (117V).

Reference Supply -

9. 500V Calibration - With the ADJ. CAL. pot in its center of rotation

adjust R121 until reference is 500.0 ±.2V.

10. Reference voltage ripple, eo - Ripple voltage at V102 of pin 3 should not exceed 8 mv ac.

11. Reference Supply Regulation - Observe dc 500V reference voltage at V102 pin 3. Voltage must not change by more than 50 mv dc as line voltage is varied between 104-130V. At the same time observe the filament voltage on V102. Filament regulation should be .4V or less. Between high and low line the voltage should be between 5.5V and 6.6V.

    Return line voltage to 117V and monitor voltage carefully for 30 seconds while lightly tapping instrument. Voltage must not change erratically.

Null Detector

12. +Eo Regulation - Observe voltage at V204 pin 5. Voltage must not change by more than 2V as line voltage is varied between 104 and 130V.

13. Ripple, +eo - Ripple voltage at V204 pin 5 should not exceed 15 mv.

14. VTVM Zero Adjust - Check mechanical meter zero then place instrument in case. At 117V line with chassis ground connected to line ground, adjust R227 for a good null on the meter.

15. Rattle - Observe meter closely. Random excursions of meter needle should be less than 1/4 small division. Critical components - chopper, EF86.

16. VTVM Offset Check - With K-V dialed to zero, turn NULL knob from VTVM to 10V - 1V - .1V - .01V. Meter should not deflect from null by more than 1/4 small division.

17. VTVM Zero Stability - With null switch in VTVM position, vary line from 104 - 130V. Meter needle must return to within 1/4 small division of its original reading.

18. VTVM Sensitivity - Turn NULL switch to VTVM position. Apply 500 volts to the instrument and adjust meter sensitivity (R219) for full scale right deflection. Reverse the polarity of the 500V input and deflection to the left must be within 1/2 small division of full scale.

19. Meter Linearity - Apply voltages from 0 to 500V to the instrument in 100V steps. Meter must read accurately to within 3/4 small division at all times. Reverse polarity and repeat all readings.

20. Null Sensitivity Check - Set instrument to 500V Range, K-V to zero, and short input. Turn null switch to 10V position and turn K-V "B" dial to 1, meter needle must deflect to within 1 small division of full scale.

21. Recorder Output Check - Measure mercury cell on .01 NULL range. Plug in a 801 or 801H into the recorder output. Turn K-V "C" dial of the unit under test and observe on the 801 (on .1V null) that the 801 meter follows the deviation on the instrument under test.

22. Polarity Reversal - Null out the voltage of the mercury cell on the .01V range. Reverse polarity - reading should be within 1/2 small division.

23. VTVM Leakage - Turn RANGE switch to 500V, NULL switch to .1V null sensitivity, and check meter zero with input posts open. Turn K-V "A" dial slowly to 4 and "B" dial slowly to 9. Meter offset must not exceed 2 small divisions.

Final Calibration

NOTE: Check mechanical and electrical zero.

24. Calibrate VTVM - This is mainly a cold check of the VTVM calibration.

25. Calibrate 500V - With instrument in the 500V range, dial up 499.910 on K-V, apply a voltage of 500 ±.01V. Next null out the 500V on the .1V null range by adjusting the external calibrate pot. While at null turn the Operate-Calibrate switch to Calibrate, then carefully adjust R318 to null on the meter.

26. Check 50V VTVM - Put 50V into input and check accuracy of 50V VTVM position. Meter needle must deflect within 3/4 small division.

27. Calibrate 49.9910. Null out 50V in the .01 null range by adjusting R323.

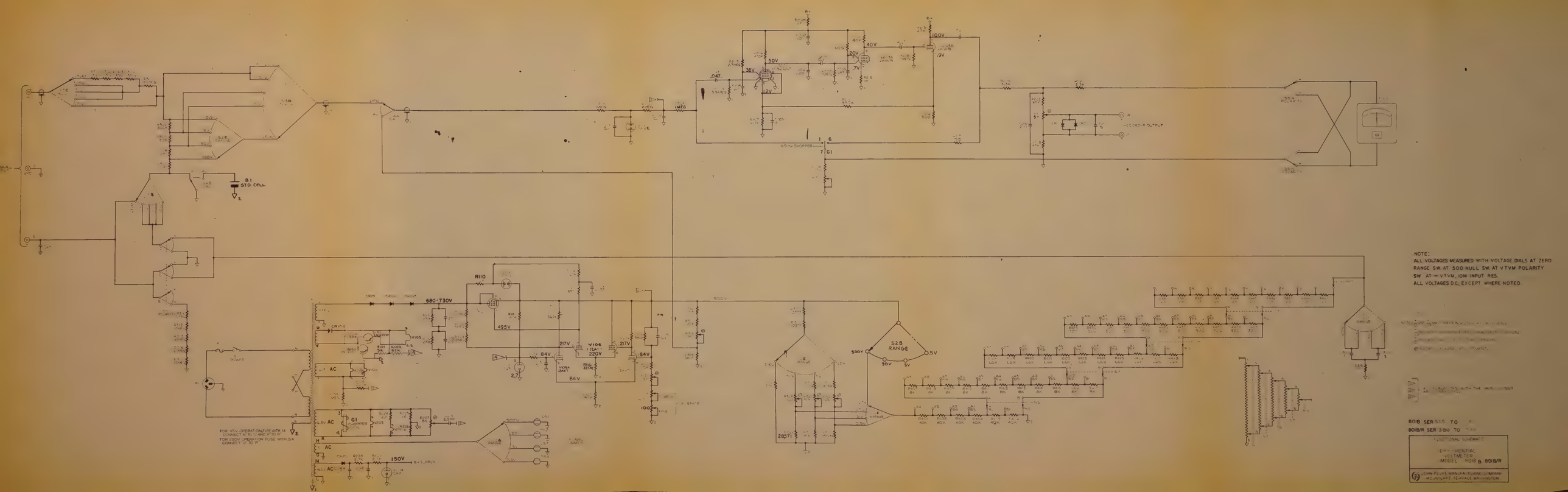
28. Check 5V - VTVM.

29. Calibrate 4.99910.

30. Check .5V - VTVM.

31. Calibrate .499910.

32. Measure 100V from the 525 by dialing up 99.910 and 100.00V on the K-V. Reading should be within ±10 mv.



NOTE:
ALL VOLTAGES MEASURED WITH VOLTAGE DIALS AT ZERO
RANGE SW. AT 500 NULL SW. AT VTVM POLARITY
SW AT + VTVM, 10M INPUT RES.
ALL VOLTAGES DC, EXCEPT WHERE NOTED.

801B SER 515 TO
801B/R SER 380 TO

SCHEMATIC
DIFFERENTIAL
VOLTMETER
MODEL 801B & 801B/R

JOHN FLUKE MANUFACTURING COMPANY
MOUNTLAKE TERRACE WASHINGTON

FLUKE

TECHNICAL DATA

801H VOLTMETER

MODEL 801H

MODEL 801H PRECISION DIFFERENTIAL DC VOLTMETER

FEATURES

Accuracy 0.05% of input voltage

5 Microvolt resolution

Infinite input resistance

Standard cell reference

Automatic lighted decimal, in-line readout

New taut band suspension meter

SPECIFICATIONS

AS A PRECISION POTENTIOMETER

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING	DIAL RESOLUTION	INPUT RESISTANCE PER VOLT OF INPUT VOLTAGE AT NULL	1% OFF NULL
50-500	1 - 0 - 1	0.01 V	Infinite	1,000 Meg.
5-50	0.1 - 0 - 0.1	0.001 V	Infinite	10,000 Meg.
0.5-5	0.01 - 0 - 0.01	0.0001 V	Infinite	10,000 Meg.
0-0.5	0.001 - 0 - 0.001	0.00001 V	Infinite	100,000 Meg.

*Any null range may be used at any input voltage; recommended ranges are those most useful.

ACCURACY:

±0.05% of input voltage from 0.1 V to 500 V.

±0.1% of input voltage or ±0.05 mv, whichever is greater, below 0.1 V.

These accuracies obtained when recommended ranges are used.

SPECIFICATIONS

AS A CONVENTIONAL VACUUM TUBE VOLTMETER

VOLTAGE RANGES	INPUT RESISTANCE	SCALE DEFLECTION
0 to ±500 V	10 Meg.	500 - 0 - 500
0 to ±50 V	10 Meg.	50 - 0 - 50
0 to ±10 V*	10 Meg.	10 - 0 - 10
0 to ±5 V	10 Meg.	5 - 0 - 5
0 to ±1 V*	10 Meg.	1 - 0 - 1
0 to ±0.5 V	10 Meg.	0.5 - 0 - 0.5
0 to ±0.1 V*	10 Meg.	0.1 - 0 - 0.1
0 to ±0.01 V*	1 Meg.	0.01 - 0 - 0.01
0 to ±0.001 V*	1 Meg.	0.001 - 0 - 0.001

ACCURACY: 3% on all ranges. *These ranges obtained by setting NULL switch to desired sensitivity with the 5 voltage dials set to 0.

STABILITY OF REFERENCE SUPPLY:
0.01% for change in line voltage (105 V to 130 V)
0.01% per hour after warmup

STABILITY OF METER ZERO:
4% of full scale for 20% change in line voltage
2% per hour after warmup

CALIBRATION:
500 Volt reference supply calibrated against built-in standard cell

INPUT POWER:
105 - 130 Volts, 60 cycles, 60 watts

DIMENSIONS:
9-3/4" wide x 13" high x 14" deep - standard model
19" wide x 8-3/4" high x 16-3/4" deep - rack mounting model

FINISH AND WEIGHT:
Smooth grey baked enamel. Grey baked wrinkle case.
Cabinet model - 25 lbs.; rack mounting model - 28 lbs.

PRICE: Cabinet model - $555.00
Rack model - $575.00
All prices f.o.b. factory, Seattle, Washington

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 801H

TEST PROCEDURE

A. VISUAL INSPECTION

1. Check front panel engraving for accuracy and quality. Check that Kelvin-Varley resistor group tag and tube location decal are attached to instrument.

2. Check front panel controls to insure that all knobs are tight and properly oriented, and that moving parts do not bind.

3. Check placement of all components on front panel and on main chassis, with emphasis on proper attachment and quality of workmanship.

4. Check all solder joints.

5. Check appearance of all harnesses, with emphasis on proper routing and quality of workmanship.

B. PRELIMINARY CHECKS

1. Resistance:
   Measure resistance between negative binding post and chassis. Must be infinite. Set RANGE switch to 500V, NULL switch to VTVM, and K. V. dials to 0.

2. Input Power:
   Set power variac to 0 and turn instrument on. Slowly increase variac setting while monitoring input power. Input power should never exceed 78 watts. Increase variac setting to 117V. Input power should be 85-95W. Monitor input power while continuing preliminary checks and be alert for smoke or other evidence of trouble. Increase variac setting to 130V and check for any failure. Return variac to 117V for remaining checks.

3. Voltage measurements (with respect to negative bin ding post).
   (a) 500V reference supply: Voltage at V-5 pin 3 should be 490-510V dc. Vary input voltage from 105-130 volts and observe that supply regulates over this range. Return input voltage to 117V.

   (b) VTVM aux, supplies: Voltage at V201 pin 5 should be +100 to 110 volts. Check for proper regulation as in step 3 (a). Voltages at V202 pin 2 should be -100-110V. Check for proper regulation as in step 3 (a). Voltage at C204 (neg. side) should be -1. 25-1. 4V. Voltage at C218 (pos. side) should be +1. 25 to 1. 4V.

(c) VTVM fil. supply: Voltages at Q201 emitter should be -12.0-12.6V. Check for proper regulation as in step 3 (a).

(d) Reference supply fil. (V8, 12AX7): Voltages from pin 4 to pin 9 of V8 should be 6.0-6.5V. Check for proper regulation as in step 3 (a).

4. Decimal Lights
Check that proper decimal light is on as RANGE switch is turned through all positions. Return RANGE switch to 500V position.

5. Zero adjustment - Center front panel zero knob and zero meter by adjusting R218 (Center Pot) on the VTVM chassis.

6. Range Resistor and VTVM Operational Check.
(a) 500V Range: Place a short between positive and negative binding posts, turn NULL switch to 10V, and check zero. Turn K.V. "B" dial to 1 and adjust meter sensitivity R211 (Front Pot) for full scale left deflection. Turn K.V. "B" dial to 0. Turn NULL switch to 1V and K.V. "C" dial to 1. Meter should deflect full scale left ±2 small divisions. Turn K.V. "C" dial back to 0. Turn NULL switch to .1V and K.V. "D" dial to 1. Meter should deflect full scale left ±2 small divisions. Turn K.V. "D" dial back to 0.

(b) 50V Range: Turn RANGE switch to 50V position, NULL switch to 10V, and K.V. "A" dial to 1. Meter should deflect full scale left within ±2 small divisions. Turn K.V. "A" dial back to 0. Repeat above step systematically changing NULL switch position, turning appropriate K.V. dial, and observing meter deflection until all possible combinations have been checked.

(c) 5V Range: Repeat checks similar to those in step 6 (b) with RANGE switch in 5V position. Meter should deflect full scale left within ±2 small divisions.

(d) .5V Range: Repeat checks similar to those in step 6 (b) with RANGE switch in .5V position. Meter should deflect full scale left ±2 small divisions.

C. BAKE

Operate instrument on normal line voltage for not less than 24 hours.

D. PRE-CALIBRATION CHECKS

Note: All measurements are with respect to negative binding post unless otherwise stated. Start each check with normal line voltage (117V).

1. Reference Supply.
(a) High voltage, Ebb: Voltages at V-2 pins 5 and 6 should be 920-980V dc.

(b) Pre-regulator output, Eo: Voltage at V-5 pin 1 should be 620-670V dc.

(c) Pre-regulator ripple, eo: Ripple voltage at V-5 pin 1 should not exceed 100 mv ac.

(d) Pre-regulator control range, Emin: Lower the line voltage to the instrument and observe the voltage at which control is lost. Should be less than 100V ac.

(e) Reference voltage ripple, eo: Ripple voltage at V-5 pin 3 should not exceed 8 mv ac.

(f) Reference control range, Emin: Check for proper control as in step 1 (d).

(g) Series tube bias ec: Measure voltage between V-5 pin 3 and V-5 pin 2. Lower the line voltage to 100V. Bias voltage must be at least - 2V dc.

(h) Reference filament regulation: Voltage at V-8 from pins 3, 4, 5, 8 to pin 9 (measure across R1) should be between 6.0 and 6.5V ac. Voltage must not change by more than .8V ac as line voltage is varied between 105V and 130V.

(i) Reference supply regulation: Observe voltage at V-5 pin 3. Voltage must not change by more than 50 mv dc as line voltage is varied between 100V and 130V. Return line voltage to 117V and monitor voltage carefully for 1 minute while lightly tapping instrument. Voltage must not change more than an additional 30 mv.

(j) 1V Sample: Turn CAL switch to cal reference position and check that reference voltage is exactly 500.00V. Turn CAL switch to cal adjust position and adjust R36 until meter indicates exactly the same as it did with the CAL switch in the cal reference position. It should now be possible to internally calibrate the instrument with the adjust cal pot essentially centered.

(k) Reference voltage, Eo: Measure voltage at V-5 pin 3. Adjust R31 until voltage is exactly 500.00V dc. Voltage should then change by at least 2.5V as adjust cal pot is varied through its range.

2. VTVM Supplies

(a) +Eo: Voltage at V-201 pin 5 should be +100V to +110V.

(b) Ripple, +eo: Ripple voltage at V-201 pin 5 should not exceed 15 mv.

(c) +Eo control range +Emin: Check for proper control range as in step 1 (d).

(d) +Eo regulation: Observe voltage at V201 pin 5. Voltage must not change by more than 1V as line voltage is varied between 100V and 130V.

(e) -Eo: Voltage at V-202 pin 2 should be -100V to -110V.

(f) Ripple, -eo: Ripple voltage at V-202 pin 2 should not exceed 10 mv.

(g) -Eo control range, -Emin: Check for proper control range as in step 1 (d).

(h) -Eo regulation: Observe voltage at V-202 pin 2. Voltage must not change by more than 1V as line voltage is varied between 100V and 130V.

(i) Bias voltages, ±Ec: Measure voltages across C204. Voltages should be ±1.25V to ±1.40V.

(j) VTVM filament voltage, Ef: Voltage at Q201 emitter should measure -12.0V to -12.6V dc.

(k) VTVM filament ripple, ef: Ripple voltage measured at Q201 emitter must not exceed 10 mv.

(l) VTVM filament control range: Check for proper control range as in step 1 (d).

(m) VTVM filament regulation: Voltage at Q201 emitter must not change more than .12V as line voltage is varied from 100V to 130V.

3. VTVM Circuits

(a) Element potentials:

(1) V205 pin 5 50 - 60V
(2) V205 pin 6 30 - 40V
(3) V204 pin 6 54 - 65V
(4) V204 pin 1 56 - 70V

(b) VTVM zero stability: Turn RANGE switch to 5V, operate switch to REF, check meter zero. Meter offset must not exceed 2 small divisions as the line voltage is varied between 100 and 130V. Rattle: With OP switch in REF. zero meter. Total rattle should not exceed 3/4 sd. (If rattle is excessive change the 12AU6. (RCA brand is preferred).

(c) VTVM sensitivity: Turn NULL switch to VTVM position. Apply 500 volts to the instrument and adjust meter sensitivity (R211) for full scale right deflection. Reverse the polarity of the 500V input and deflection to the left must be within 1/2 small division of full scale. If 1/2 small division of full scale is exceeded split the difference, but don't exceed 1/2 sd. at either end.

(d) Meter linearity: Apply voltages from 0 to 500V to the instrument in 100V steps. Meter must read accurately to within 1/2 small division at all times. Reverse polarity and repeat all readings.

4. VTVM range resistors

(a) 50V Range: Turn RANGE switch to 50V position and apply 50V to the instrument. Meter must indicate full scale within 1/2 small division.

(b) 5V Range: Turn RANGE switch to 5V and apply 5V. Meter must indicate full scale within 1/2 small division.

(c) .5V Range: Turn RANGE switch to .5V and apply .5V. Meter must indicate full scale within 1/2 small division.

(d) VTVM leakage: Turn RANGE switch to 500V, NULL switch to 1V null sensitivity, and check meter zero with input posts open. Turn K.V. "A" dial slowly to 4 and "B" dial slowly to 9. Meter offset must not exceed 1/4 small division.

(e) Kelvin-Varley linearity: Turn RANGE switch to 500V, NULL switch to 1V, and K.V. dials to 500. Zero instrument with input posts open and then apply approximately 500V to the instrument. Adjust the applied voltage until the meter indicates a null. Turn NULL switch to VTVM position, K.V. dials to 400, and reduce input to instrument to 400V. Turn NULL switch to 1V and observe meter offset (amount off null). Error must not exceed .01% (40 mv). Systematically turn the NULL switch to VTVM change the K.V. setting, reduce the input to the instrument, and check meter offset in the 1V null sensitivity until every K.V. setting has been checked. Error must not exceed .01% or 5 mv whichever is greater.

5. Chopper Circuits

(a) Null sensitivity (10V, 1V): Set up instrument to measure 255V. Apply approximately 255V to the instrument, turn NULL switch to 1V, and adjust applied voltage until meter indicates null. Change K.V. "C" dial from 5 to 4 and from 5 to 6. Meter must deflect full scale to right and full scale to left within 1/2 small division. Turn NULL switch to 10V and change K.V. "B" dial from 5 to 4 and from 5 to 6. Again meter must deflect within 1/2 small division of full scale.

(b) Null sensitivity (.1, .01, .001V): Set all K.V. dials to zero, RANGE switch to 5V, NULL switch to .001V. Short input posts, zero meter, and set "D" dial to 1. Adjust R212 (Back Pot) so that meter reads full scale left. Set up instrument to measure 2.5550V. Apply approximately 2.5550 volts, turn NULL switch to .001 and adjust applied voltage until meter indicates null. Change K.V. "D" dial from 5 to 4 and 5 to 6. Meter must deflect within 3 small divisions of full scale. Turn NULL switch to .01 and change K.V. "C" dial from 5 to 4 and 5 to 6. Meter must deflect

within 1/2 small division of full scale. Turn NULL switch to .1V and change K. V. "B" dial from 5 to 4 and from 5 to 6. Meter must deflect within 1/2 small division of full scale.

801H TROUBLESHOOTING

The following chart list various trouble symptoms, possible causes, and/or remedies. It is recommended that tube substitution be tried before any other tests are made. If tubes known to be good do not clear the trouble, voltage and resistance measurements should then be made.

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
Excessive Drift in 500 Volt Reference Supply	This is normally shown by the need to re-calibrate the instrument every 5 to 10 minutes. The trouble is usually caused by one of the following: 1. A defective reference tube (V6 or V7). 2. A faulty equating tube (V8). 3. A leaky feedback capacitor (C12.).
Excessive Drift in VTVM	The drift should stop after a few minutes operation. If it does not, replace the V205.
Inability to Calibrate Instrument	If meter deflection cannot be reduced to zero by the steps outlined in paragraph 3-2 of Section III, the trouble is in one of the following areas: 1. Either R30, R31, or R32 has shifted, making it impossible to bring the output of the super-regulator to 500 Volts. Rotate R31 until instrument can be calibrated. 2. V6 and/or V7 have aged to the point where their running voltage is too low. This voltage should be from 85 to 87 Volts. If it is possible, replace the defective tubes. In an emergency a precision wirewound resistor may be added at jumper X at the forward edge of the printed circuit board in order to compensate for reference tubes with low running voltages. Screwdriver adjust control R31 may be adjusted to bring the ADJ CAL control to the approximate

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
	center of rotation when the meter deflection has been reduced to zero. Only add a resistor under emergency conditions and then use only a precision wirewound resistor wired with either Evenohm, Karma, or Manganin alloys. DO NOT UNDER ANY CONDITIONS ATTEMPT REPLACEMENT WITH ORDINARY POWER RESISTORS, NICHROME RESISTORS, CARBON OR DEPOSITED CARBON RESISTORS, OR ANY METAL FILM RESISTORS. THIS STATEMENT APPLIES TO EVERY PRECISION WIREWOUND RESISTOR IN THE INSTRUMENT. 3. One of the three wirewound resistors (R33, R34, R35) in the standard cell sampling string has changed value. If replacement of any of these resistors is necessary, the instrument must be recalibrated. 4. The standard cell may have shifted value. The cell should measure between 1.0190 Volts and 1.0196 Volts. The standard cell must be measured with a precision potentiometer such as the John Fluke Model 801 or the Leeds & Northrup Type K potentiometer. DO NOT USE A VOLT-OMETER. If replacement of the cell is necessary, the 801H must be recalibrated. 5. The rectifier filter (V1 and C1A, B, C), the super-regulator power supply (V5, V6, V7, and V8), or the pre-regulator (V2, V3, and V4 has failed. The output of the rectifier filter should be approximately 900 Volts at a line voltage of 117 Volts. The output of the pre-regulator should be from 610 to 640 Volts and be regulated to better than 1% over a range of 100 to 130 Volts line. The output of the super regulator must be 500 Volts and should have a range of adjustability of ±5 Volts. Regulation in this case must be 0.01% or better for a line voltage range of 100 to 130 Volts.

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
Error in Excess of Specified Values	This is caused either by the instrument being out of calibration or by a defective resistor in the five-dial Kelvin-Varley voltage divider. 1. To determine whether the divider is satisfactory, proceed as follows: a. Set the five voltage dials to 400.00 and apply an EMF from a stable, high resolution power supply such as the John Fluke Models 301C, 406, or 407. b. Adjust the power supply until a null is obtained in the 1 Volt range. c. Remove the voltage from the input and reset the five voltage dials to 399.910. d. Reconnect the 500 Volts to the input NULL switch in the 1 Volt position. The meter should null within 80 millivolts (0.02%. e. Repeat this check by applying 50 Volts and setting up 50.00 on the voltage dials and then 49.910. A difference in the two readings must be less than 25 millivolts (0.05%). 2. If it appears that the five-dial Kelvin-Varley Voltage Divider is satisfactory, check to determine whether the instrument is in calibration. There are four calibration adjustments. The basic adjustment concerns the 500 Volt range and is adjusted by screwdriver adjust rheostat R36. This adjustment affects not only the 500 Volt

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
	range, but the 50 Volt, 5 Volt, and the 0.5 Volt ranges as well. The lower three ranges are adjusted by individual adjustment rheostats, R124, R126, and R129, respectively. These three adjustments are completely independent in that they have no effect on each other nor on the 500 Volt adjustment (R36). In checking the calibration, the 500 Volt range must be the first consideration, as if this is out of calibration all three lower ranges will also be out. To check the 500 Volt range perform the calibration operation as outlined in paragraph 3-2, Section III. Then apply a known 500 Volt (this source must be accurate to 0.01% or better) to the instrument and measure it. The Kelvin-Varley dials must read between 499.90 and 500.10 Volts, (±0.02%). If it reads outside of these limits, see the following recalibration Instructions: NOTE: A 500 Volt EMF accurate to 0.01% is extremely difficult to obtain. If there is any doubt as to the accuracy of the 500 Volt, DO NOT USE IT. Instead, contact the John Fluke Field Representative in your area, as he will usually be able to provide an approved precision calibration set-up. Refer also to the recommended calibration set-up in this manual. If the error appeared in one of the three lower voltage ranges, but the basic 500 Volt calibration was found to be off and recalibration performed, reset the lower range that was in error to determine whether the recalibration of the 500 Volt range corrected the error. If not, proceed as follows:

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
	a. Assuming the error appeared in the 5 Volt range, set the RANGE knob to the 5 Volt position. b. Apply a known 5 Volts (this voltage must be accurate to 0.01% or better) to the instrument and measure it. c. The Kelvin-Varley dials should read between 4.999 and 5.001 Volts (±0.03%). If it reads outside of these limits, see the following recalibration instructions: NOTE: As stated above, if there is any doubt as to the accuracy of the input voltage, contact the John Fluke Field Representative in your area for an approved precision calibration set-up.
Error in the VTVM Reading	1. If the error is in the VTVM and all NULL ranges, adjust the 10 millivolt gain (R212). 2. If the error is in the 0.001 range only, adjust R212. 3. If the error is in the VTVM range only, check the divider resistor. NOTE: DO NOT USE A SHARP POINTED TOOL AROUND THE SWITCH DIVIDERS. IF A DEPOSITED CARBON RESISTOR COATING IS SCRATCHED DEEPLY ENOUGH, THE RESISTOR WILL OPEN.

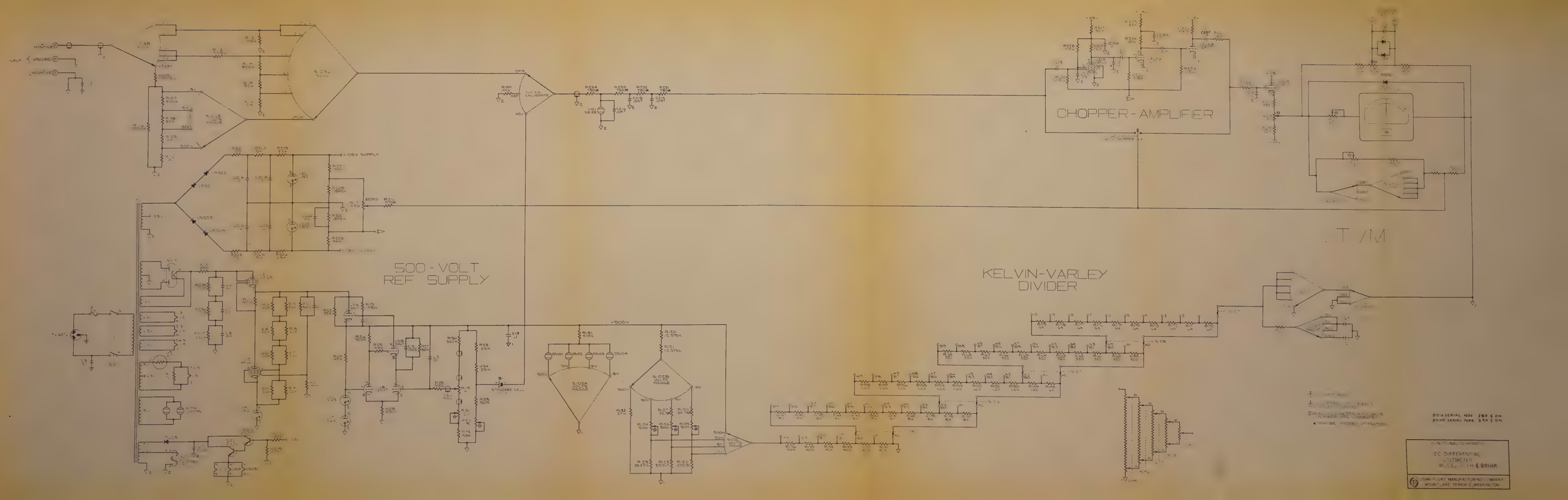
SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
Meter needle offsets to the left as voltage dial settings are increased, i.e. NULL switch in 1 Volt position, RANGE switch in 500 Volt position, and nothing connected to input posts	This normally indicates that there is leakage between the positive post and ground. See paragraph 5-1, "General Cleaning," for a description of this.
Excessive error which appears only at low voltages when operating in the 1 Volt NULL range.	This normally is caused by defective wirewound resistors on S108 or S109. See the previous troubleshooting paragraph regarding Kelvin-Varley non-linearity.
Meter needle wobble with signal applied.	The trouble may be in: (1)the source under measurement; (2)in the bucking voltage developed in the 801H; or (3)in the VTVM CIRCUIT. To check the first two possibilities, apply an absolutely steady voltage and see if the wobble ceases. If it does, the trouble was in the source under measurement. If the wobble is still present, remove the signal from the input posts. If wobble is still present, the trouble is in the VTVM. If it disappears the trouble is either in the 500 Volt reference supply, the Kelvin-Varley Divider, or if operating in other than the 500 Volt range one of the three range dividers. To track down trouble in the 500 Volt reference supply, use another ℱ Model 801H, 801, or 800 and monitor the output of the 500 Volt reference on the defective 801H. If the 500 Volts is steady, the trouble is in the Kelvin-Varley dividers or the range dividers. If the 500 Volts is not stable, the trouble may be: (1)R30, R32, or R24; (2) any of the tubes in the supply; (3)problems in the 650 Volt pre-regulator; or (4) a leaky feedback capacitor (C12).

SYMPTOM	CAUSE AND/OR POSSIBLE REMEDY
Meter needle wobble with no signal applied.	This is usually caused by a microphonic 12AU6 (V205) or defective regulator tube (V201, or V202).
	Ocassionally this wobble will appear only periodically; at a low frequency rate of perhaps once a second and at an amplitude equal to one small scale division. This is often caused by a defective regulator tube (V201 or V202) and occasionally by V205.
Inability to bring meter needle to zero	This may require adjustment of 218, which is used to center R117, the front panel zero control.
Meter offset when switching from 0.001 V to 0.01 V on NULL range.	Check mechanical zero.

801H TEST REPORT

Serial Number						
Date - Time						
A. VISUAL INSPECTION						
B. PRELIMINARY CHECKS	Test Limits					
1. Resistance	Infinite					
2. Input Power	85 - 95 W					
3. Voltage Measurements	xxxxx					
a. 500V Ref.	490-510V					
b. (1) + VTVM Aux.	+100 to +110V					
(2) - VTVM Aux.	-100 to -110V					
(3) VTVM Neg. Bias	-1.25 to -1.4V					
(4) VTVM Pos. Bias	+1.25 to +1.4V					
c. VTVM Fil.	-12.0 to -12.6V					
d. Ref Supply Fil	6.0 to 6.5 V ac					
4. Decimal Lights	xxxxx					
5. Meter Zero	xxxxx					
6. Range Resistor & VTVM	xxxxx					
a. 500V	FS ±2 sd					
b. 50V	FS ±2 sd					
c. 5V	FS ±2 sd					
d. .5V	FS ±2 sd					
C. BAKE	xxxxx					
D. PRE-CAL CHECKS	xxxxx					
1. Ref. Supply	xxxxx					
a. Ebb	920-980V					
b. Eo pre-reg	620-670V					
c. eo pre-reg	< 150 mv ac					
d. Emin pre-reg	<100V					
e. eo ref	<8 mv ac					
f. Emin ref	<100V					
g. e_c V-5	>-2V					
h. Ref. Fil (100-130V)	<.8V ac					
i. E_o ref reg. (100-130V)	50 mv tap 30 mv					
j. 1V Sample	1V					
k. E_o ref	500V (2.5V)					
2. VTVM Supplies	xxxxx					
a. Twin Tee	60 db					
b. + E_o	+100 to +110V					
c. + eo	15 mv ac					

	Test Limits	Serial Numbers				
d. + Emin	<100V					
e. + E_o Reg. (100-130V)	<1V					
f. -E_o	-100 to -110V					
g. -e_o	10 mv ac					
h. -Emin	<100V					
i. -E_o Reg. (100-130V)	<1V					
j. VTVM Bias (+ & -)	±1.25 to ±1.4V					
k. Ef (VTVM)	-12.0 to -12.6V					
l. ef	10					
m. E_f min	100V					
n. E_f Reg. (100-130V)	.12V					
3. VTVM Circuits	xxxxx					
a. Element Potentials	xxxxx					
(1) V205 pin 5	50-60V					
(2) V205 pin 6	30-40V					
(3) V204 pin 6	54-65V					
(4) V204 pin 1	56-70V					
b. Zero stab. (100-130V)	<2 sd					
c. VTVM sensitivity	<1/2 sd					
d. Linearity	<1/2 sd					
4. VTVM Range Res.	xxxxx					
a. 50V	<1/2 sd					
b. 5V	<1/2 sd					
c. .5V	<1/2 sd					
d. Leakage	<1/4 sd					
e. K-V Linearity	.01% or 5 mv					
5. Chopper Ckts	xxxxx					
a. Null sensitivity	xxxxx					
(1) 1V	<1/2 sd					
(2) 10V	<1/2 sd					
b. Null sensitivity	xxxxx					
(1) .001V	<3 sd					
(2) .01V	<1/2 sd					
(3) .1V	<1/2 sd					

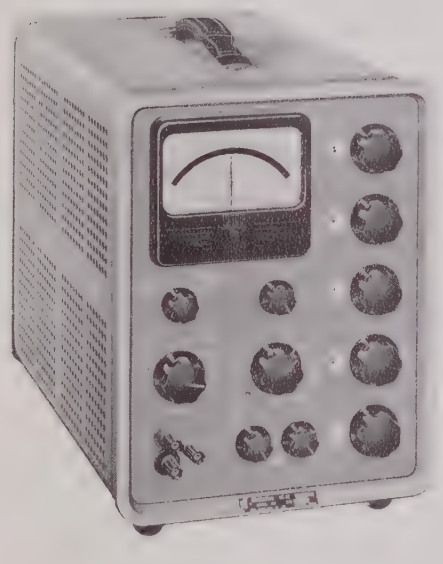

CHOPPER - AMPLIFIER
500 - VOLT
REF SUPPLY
KELVIN-VARLEY
DIVIDER
T/M
EC DIFFERENTIAL
VOLTMETER
MODEL 419M & 420HR

FLUKE

TECHNICAL DATA

803 VOLTMETER

MODEL 803 PRECISION AC/DC DIFFERENTIAL VOLTMETER



FEATURES

DC accuracy 0.05% of input voltage

AC accuracy 0.2% of input voltage

Direct in-line readout

Automatic lighted decimal

Standard cell reference

Converter frequency response 30 cps to 10 KC

DC Multipliers available for use to 30 KV

Recorder Output Provisions

APPLICATIONS

Vacuum tube voltmeter

Differential DC voltmeter

Differential AC voltmeter

Calibration standard

INTRODUCTION

The Model 803 Precision Differential Voltmeter is a compact, highly accurate portable voltmeter designed for precise measurement of both AC and DC voltage.

This instrument will measure 0.1 to 500 volts DC accurate to ±0.05%, or 0.5 to 500 volts AC accurate to ±0.2% over a frequency range of from 30 cps to 10 KC. It has infinite DC input impedance at null, and one megohm, 25 micro-microfarad AC impedance at null.

Ease of operation and inherent protection from accidental overload combined with high accuracy and resolution, assures equal suitability for production line testing or precision laboratory measurements.

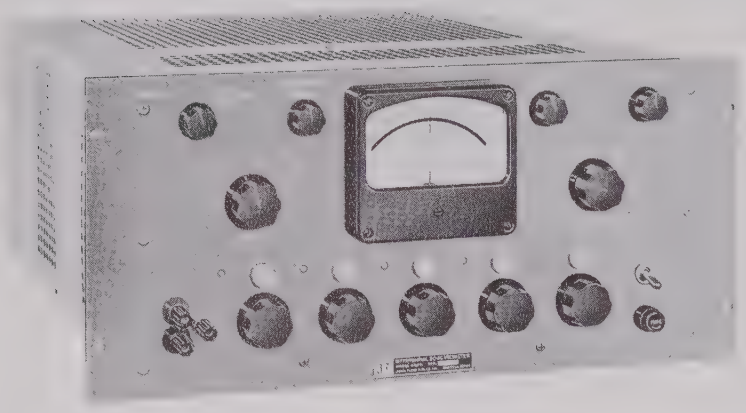
The Model 803 operates on the basic principle of comparing an unknown voltage with a precisely known voltage. Any difference between the two is indicated on a sensitive null detector. The circuit consists of four main elements which are:

1. An extremely stable 500 volt DC reference supply, with a means for setting this reference exactly to 500 volts.

2. A network of range resistors for dividing the 500 volt reference down to three lower reference voltages of 50, 5, and 0.5 volts, and a precision five-dial Kelvin-Varley divider for selecting an accurate, known portion of one of the four reference voltages.

3. A calibrated multi-range VTVM which is used both as a conventional VTVM for determining the approximate value of the unknown voltage, and as a null detector for measuring the difference between the unknown voltage and the internally generated voltage.

4. An AC to DC converter which is used for all AC measurements to convert the unknown AC voltage to a DC voltage.



The Model 803R embodies the same quality features and characteristics as the Model 803. Equipped with hard rubber feet, this unit can also be used for bench-top work.

SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

VOLTAGE RANGES:

	Input Voltage Range	Recommended Null Range	Input Impedance At Null
DC	50-500	10-0-10	Infinite
		1-0-1	"
	5-50	1-0-1	"
		0.1-0-0.1	"
	0.5-5	0.1-0-0.1	"
		0.01-0-0.01	"
	0-0.5	0.1-0-0.1	"
		0.01-0-0.01	"
AC	50-500	10-0-10	1M, 25 uuf
		1-0-1	"
	5-50	0.1-0-0.1	"
		0.1-0-0.1	"
	0.05-5	0.1-0-0.1	"
		0.01-0-0.01	"

RESOLUTION:

	Input Voltage Range	Dial Resolution (Volts)	Meter Resolution (Volts)
DC	50-500	0.01	0.005
	5-50	0.001	0.0005
	0.5-5	0.0001	0.00005
	0-0.5	0.00001	0.00005
AC	50-500	0.01	0.005
	5-50	0.001	0.0005
	0.05-5	0.0001	0.00005

ACCURACY:

DC ± 0.05% of input voltage from 0.1 to 500V
± 0.1% of input voltage or 0.00005V, whichever is greater from 0.to 0.1V

AC ± 0.2% of input voltage from 0.5 to 500V. reduced accuracy from 0.05 to 0.5V

AS A VACUUM TUBE VOLTMETER

VOLTAGE RANGES:

	Input Voltage Range	Input Impedance
DC	± 500	10M
	± 50	10M
	± 5	10M
	± 0.5	10M
	± 10*	10M
	± 1*	10M
	± 0.1*	1M
	± 0.01*	1M
AC	0-500	1M, 25 uuf
	0-50	"
	0-5	"
	0-100*	"
	0-10*	"
	0-1*	"
	0-0.1*	"
	0-0.01*	"

*Using Null Ranges

VTVM ACCURACY: ±3%

GENERAL SPECIFICATIONS

Input Voltage:	117/220/234 V, 60 cps, single phase (50 or 400 cps models available on request)
Input Power:	175 watts
Input Polarity:	+ or -, floating
Reference Stability:	±0.01% maximum for 105 to 130 volts line ±0.01% per hour after 30 minute warmup
AC to DC Converter Frequency Response:	30 cps to 10 KC
Size:	Cabinet Model - 13"H x 9-3/4"W x 16" D Rack Model 8-3/4"H x 19"W x 17-5/16"D
Net Weight:	Cabinet Model - 30 pounds Rack Model - 38 pounds
Price:	Cabinet Model - $875.00 Rack Model - $895.00

All prices f.o.b. factory, Mountlake Terrace, Wash.

10-1-61

Electronics FOR INDUSTRY

FLUKE
JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

803 TEST PROCEDURE

A. VISUAL INSPECTION

1. Check front panel engraving for accuracy and quality. Check that Kelvin-Varley resistor group tag and tube location decal are attached to instrument.

2. Check front panel controls to insure that all knobs are tight and properly oriented, and that moving parts do not bind.

3. Check placement of all components on front panel and on main chassis, with emphasis on proper attachment and quality of workmanship.

4. Check all solder joints.

5. Check appearance of all harnesses, with emphasis on proper routing and quality of workmanship.

B. PRELIMINARY CHECKS

1. Resistance.
   Remove shorting link. Measure resistance between negative binding post and chassis, and between positive binding post and chassis. Must be infinite. Connect shorting link between negative binding post and chassis; set range switch to 500V dc, null switch to VTVM, and all K-V dials to 0; center all pots.

2. Input Power.
   Set power variac to 0 and turn instrument on. Slowly increase variac setting while monitoring input power. Input power should never exceed 150 watts. Increase variac setting to 117V. Input power should be 138 to 150 watts. Monitor input power while continuing preliminary checks and be alert for smoke or other evidence of trouble. Increase variac setting to 130V and check for any failure. Return variac setting to 117V for remaining checks.

3. Voltage Measurements (with respect to chassis).
   (a) 500V reference supply: Voltage at V-5 pin 3 should be 490 to 510 volts dc. Vary input voltage from 105 to 130 volts and observe that supply regulates over this range. Return input voltage to 117V.

   (b) VTVM plate supply: Voltage at V-204 pins 1 and 6 should be 105 to 111 volts dc. Check for proper regulation as in step 3(a).

   (c) VTVM filament supply: Turn .1V - .01V zero adjustment full ccw. Voltage at V-204 pins 4 and 5 should be 6.0 to 6.5 volts ac. Check for proper regulation as in step 3(a). Return .1V - .01V zero adjustment to its center position.

   (d) 250V converter supply: Voltage at V-404 pins 1 and 6 should be 245 to 255 volts dc. Check for proper regulation as in step 3(a).

(e) 140V converter supply: Voltage at V-403 pin 6 should be 135 to 145 volts dc. Check for proper regulation as in step 3(a).

(f) 6.1V converter filament supply: Voltage at V-401 pin 4 should be -6.0 to -6.3 volts dc. Check for proper regulation as in step 3(a).

4. Decimal Lights.
Check that proper decimal light is on as range switch is turned through all dc and ac ranges. Null multiplier lights should stay off. Turn null switch to 10V null sensitivity. X10 null multiplier light should go on in 50V ac range only and X100 null multiplier light should go on in 500V ac range only. Return null switch to VTVM position and range switch to 500V dc position.

5. Zero Adjustments.
Check that meter can be zeroed with VTVM-10V-1V zero adjustment. Turn null switch to .01V null sensitivity and check that meter can be zeroed with .1V - .01V zero adjustment when instrument is in its case. Both zero adjustments should be within $\pm 90^{\circ}$ of center. Return null switch to VTVM position.

6. Range Resistor and VTVM Operational Check.
(a) 500V dc range: Place a short between positive and negative binding posts, turn null switch to 10V null sensitivity and check zero. Turn Kelvin-Varley B dial to 1 and adjust meter sensitivity (R-210) until meter deflects full scale to the left. Turn Kelvin-Varley B dial back to 0. Turn null switch to 1V null sensitivity and Kelvin-Varley C dial to 1. Meter should deflect full scale to the left within ±2 small divisions. Turn Kelvin-Varley C dial back to 0. Turn null switch to .1V null sensitivity and check zero. Turn Kelvin-Varley D dial to 1 and adjust chopper gain (R-224) until meter deflects full scale to the left. Turn Kelvin-Varley D dial back to 0. Turn null switch to .01V null sensitivity and Kelvin-Varley E dial to 1. Meter should deflect full scale to the left within ±2 small divisions. Turn Kelvin-Varley E dial back to 0 and null switch back to VTVM position.

(b) 50V dc range: Turn range switch to 50V dc position, null switch to 10V null sensitivity, and Kelvin-Varley A dial to 1. Meter should deflect full scale to the left within ±2 small divisions. Turn Kelvin-Varley A dial back to 0. Repeat above step, systematically changing null switch position, turning appropriate Kelvin-Varley dial, and observing meter deflection until all possible combinations have been checked.

(c) 5V dc range: Repeat checks similar to those in step 6(b) with range switch in 5V dc position. Meter should deflect full scale to the left within ±2 small divisions.

(d) .5V dc range: Repeat checks similar to those in step 6(b) with range switch in .5V dc position. Meter should deflect full scale to the left within ±2 small divisions.

7. Converter and Input Attenuator Operational Check.
   (a) 5V ac range: Remove short between positive and negative binding posts and turn range switch to 5V ac position. Apply 4.5V ac to the instrument by means of a variac from a stable 60 cycle source. Meter should indicate 4 to 5 volts.

   (b) 50V ac range: Turn range switch to 50V ac position and apply 45V ac to the instrument. Meter should indicate 40 to 50 volts.

   (c) 500V ac range: Turn range switch to 500V ac position and apply 115V ac to the instrument. Meter should indicate 110 to 120 volts. Turn range switch to 500V dc position and meter should indicate zero.

C. BAKE

Operate instrument on normal input voltage for a period of not less than 24 hours.

D. PRE-CALIBRATION CHECKS

NOTE: All measurements are with respect to chassis unless otherwise stated. Start each check with normal line voltage (117V).

1. Reference supply.
   (a) High voltage, E_{bb}: Voltage at V-2 pins 5 and 6 should be 900 to 960 volts dc.

   (b) Pre-regulator output, E_o: Voltage at V-5 pin 1 should be 600 to 640 volts dc.

   (c) Pre-regulator ripple, e_o: Ripple voltage at V-5 pin 1 should not exceed 100 mv ac.

   (d) Pre-regulator control range, E_{min}: Lower the line voltage to the instrument and observe the voltage at which control is lost. Should be less than 100 volts ac.

   (e) Reference voltage ripple, e_o: Ripple voltage at V-5 pin 3 should not exceed 8 mv ac.

   (f) Reference control range, E_{min}: Check for proper control as in step 1(d).

   (g) Series tube bias, e_c: Measure voltage between V-5 pin 3 and V-5 pin 2. Lower the line voltage to 105 volts. Bias voltage must be at least -2 volts dc.

(h) Reference supply regulation: Observe voltage at V-5 pin 3. Voltage must not change by more than 50 mv dc as line voltage is varied between 105V and 130V. Return line voltage to 117V and monitor voltage carefully for 1 minute while lightly tapping instrument. **Watch for abnormal response indicating a loose** connection or **a poor solder** joint.

(i) 1V sample: Turn power switch to CAL REF position and check that reference voltage is exactly 500.00V. Turn power switch to CAL ADJ position and adjust R-36 until meter indicates exactly the same as it did with the power switch in the CAL REF position. It should now be possible to internally calibrate the instrument with the adjust cal pot essentially centered.

(j) Reference voltage, E_o: Measure voltage at V-5 pin 3. Adjust R-32 until voltage is exactly 500.00 volts dc. Voltage should then change by at least 14 volts as adjust cal pot is varied through its range.

2. VTVM Supply.

(a) High voltage, E_{bb}: Voltage at positive terminal of C-202 should be 220 to 260 volts dc.

(b) High voltage ripple, e_{bb}: Ripple voltage at positive terminal of C-202 should not exceed 2 volts ac.

(c) Pre-regulator output, E_o: Voltage at V-202 pin 5 should be 145 to 155 volts dc.

(d) Pre-regulator ripple, e_o: Ripple voltage at V-202 pin 5 should not exceed 80 mv ac.

(e) VTVM supply voltage, E_o: Voltage at V-204 pins 1 and 6 should be 105 to 111 volts dc.

(f) VTVM supply ripple, e_o: Ripple voltage at V-204 pins 1 and 6 should not exceed 2 mv ac.

(g) VTVM supply control range, E_{min}: Check for proper control as in step 1(d).

(h) VTVM supply regulation: Observe voltage at V-204 pins 1 and 6. Voltage must not change by more than 20 mv dc as line voltage is varied between 105V and 130V.

(i) VTVM filament supply regulation: Measure voltage between V-204 pins 4 and 5 and V-204 pin 9. Voltage should be between 6.0 and 6.5 volts ac. Voltage must not change by more than 800 mv ac as line voltage is varied between 105 and 130V.

3. Converter Supply.

(a) 250 volt output, E_o: Voltage at V-404 pins 1 and 6 should be 245 to 255 volts dc.

(b) 250 volt ripple, e_o: Ripple voltage at V-404 pins 1 and 6 should not exceed 10 mv ac.

(c) 250 volt control range, E_{min}: Check for proper control as in step 1(d).

(d) 250 volt regulation: Observe voltage at V-404 pins 1 and 6. Voltage must not change by more than 50 mv dc as line voltage is varied between 105 and 130V.

(e) 250 volt disturbance, Δ: Observe voltage at V-404 pins 1 and 6. Voltage must not change by more than 100 mv dc at any time while the line voltage is abruptly varied between 105 and 130V, or at any time while the supply is stabilizing under the new conditions.

(f) 140 volt output, E_o: Voltage at V-403 pin 6 should be 135 to 145 volts dc.

(g) 140 volt ripple, e_o: Ripple voltage at V-403 pin 6 should not exceed 10 mv dc.

(h) 140 volt control range, E_{min}: Check for proper control as in step 1(d).

(i) 140 volt regulation: Observe voltage at V-403 pin 6. Voltage must not change by more than 300 mv dc as line voltage is varied between 105 and 130V.

(j) 140 volt disturbance, Δ: Observe voltage at V-403 pin 6. Voltage must not change by more than 1 volt dc at any time while the line voltage is abruptly varied between 105 and 130V, or at any time while the supply is stabilizing under the new conditions.

(k) -6.1 volt output, E_o: Voltage at V-401 pin 4 should be -6.0 to -6.3 volts dc.

(l) -6.1 volt ripple e_o: Ripple voltage at V-401 pin 4 should not exceed 30 mv ac.

(m) -6.1 volt control range, E_{min}: Check for proper control as in step 1(d).

(n) -6.1 volt regulation: Observe voltage at V-401 pin 4. Voltage must not change by more than 10 mv dc as line voltage is varied between 105 and 130V.

(o) -6.1 volt disturbance, Δ: Observe voltage at V-401 pin 4. Voltage must not change by more than 10 mv dc at any time while the line voltage is abruptly varied between 105 and 130V, or at any time while the supply is stabilizing under the new conditions.

4. VTVM Circuits.

(a) VTVM-10V-1V zero stability: Turn null switch to 1V null sensitivity and check meter zero. Meter offset must not exceed 2 small divisions as line voltage is varied between 105 and 130V.

(b) Cathode follower grid current: Leave null switch on 1V null sensitivity and again check meter zero. Meter offset must not exceed 1/4 small division as the negative binding post is shorted to the positive binding post. Repeat several times.

(c) VTVM sensitivity: Turn null switch to VTVM position. Apply 500 volts to the instrument and adjust meter sensitivity (R-210) for full scale deflection to the right. Reverse the polarity of the 500 volt input and deflection to the left must be within 2 small divisions of full scale.

(d) Meter stickiness: Check meter zero. Apply and remove 500 volts several times. Meter must return to zero within 1/2 small division when voltage is removed.

(e) Meter linearity: Apply voltages from 0 to 500 volts to the instrument in 100 volt steps. Meter must read accurately to within 1-1/2 small divisions at all times. Reverse polarity and repeat all readings.

5. Range Resistors and Kelvin-Varley.

(a) 50 volt range: Turn range switch to 50 volt dc position and apply 50 volts to the instrument. Meter must indicate full scale within 2 small divisions.

(b) 5 volt range: Turn range switch to 5 volt dc position and apply 5 volts to the instrument. Meter must indicate full scale within 2 small divisions.

(c) .5 volt range: Turn range switch to .5 volt dc position and apply .5 volts to the instrument. Meter must indicate full scale within 2 small divisions.

(d) VTVM leakage: Turn range switch to 500 volt dc position, null switch to 1V null sensitivity, and check meter zero with input posts open. Turn Kelvin-Varley A dial slowly to 4 and Kelvin-Varley B dial slowly to 9. Meter offset must not exceed 1/4 small division to the left.

(e) Kelvin-Varley linearity: Turn range switch to 500 volt dc position, null switch to 1V null sensitivity, and Kelvin-Varley dials to 500 volts. Zero instrument with input posts open and then apply approximately 500 volts to the instrument. Adjust the applied voltage until the meter indicates a null. Turn null switch to VTVM position, Kelvin-Varley dials to 400 volts, and reduce input to instrument to 400 volts. Turn null switch to 1V null and observe meter offset (amount off null). Error must not exceed .01% (40 mv). Systematically turn the null switch to the VTVM position, change the Kelvin-Varley setting, reduce the input to the instrument, and check

meter offset in the 1V null sensitivity until every Kelvin-Varley setting has been checked. Error must not exceed .01% or 5 mv, whichever is greater.

6. Chopper Circuits.

(a) Null sensitivity: Set up instrument to measure 255 volts. Apply approximately 255 volts to instrument, turn null switch to 1V null sensitivity, and adjust applied voltage until meter indicates null. Change Kelvin-Varley C dial from 5 to 4 and from 5 to 6. Meter must deflect full scale to right and full scale to left within 2 small divisions. Turn null switch to 10V null sensitivity and change Kelvin-Varley B dial from 5 to 4 and from 5 to 6. Again meter must deflect within 2 small divisions of full scale.

(b) Offset - Open: Turn range switch to 500 volt dc position, null switch to .01V null sensitivity, and leave input posts open. Carefully zero meter and turn null switch to .1V null sensitivity. Meter offset must not exceed 1/2 small division.

(c) Offset - Short: Do not readjust meter zero. Place a short between positive and negative binding posts and observe meter offset. Turn null switch to .01V null sensitivity and again observe meter offset. Offset must not exceed 2 small divisions in either instance.

(d) .1V - .01V zero stability: Remove input short, turn null switch to .01V null sensitivity and check meter zero. Meter offset must not exceed 2 small divisions as line voltage is varied between 105 and 130V.

(e) Chopper leakage: Turn range switch to 50 volt dc position, null switch to .01V null sensitivity, and check meter zero with input posts open. Turn Kelvin-Varley A dial slowly to 4. Meter offset must not exceed 1/4 small division to the left.

(f) Chopper gain: Turn range switch to 500 volt dc position, all Kelvin-Varley dials to zero, null switch to 1V null sensitivity and check meter zero. Turn null switch to .01V null sensitivity, connect a 39 K resistor between positive and negative binding posts, and check meter zero again. Turn Kelvin-Varley E dial to 1 and adjust chopper gain (R-224) for deflection that is 1 small division short of full scale to the left.

7. Converter Circuits.

(a) Stability: Check both zeros with range switch in 500 volt dc position. Turn range switch to 500 volt ac position, null switch to VTVM position, all Kelvin-Varley dials to zero, and place a short between positive and negative binding posts. Meter should return to zero after any switching transient and remain there. Turn range switch to 50 volt ac position and then to 5 volt ac position, observing that meter returns to zero and remains there after any switching transient.

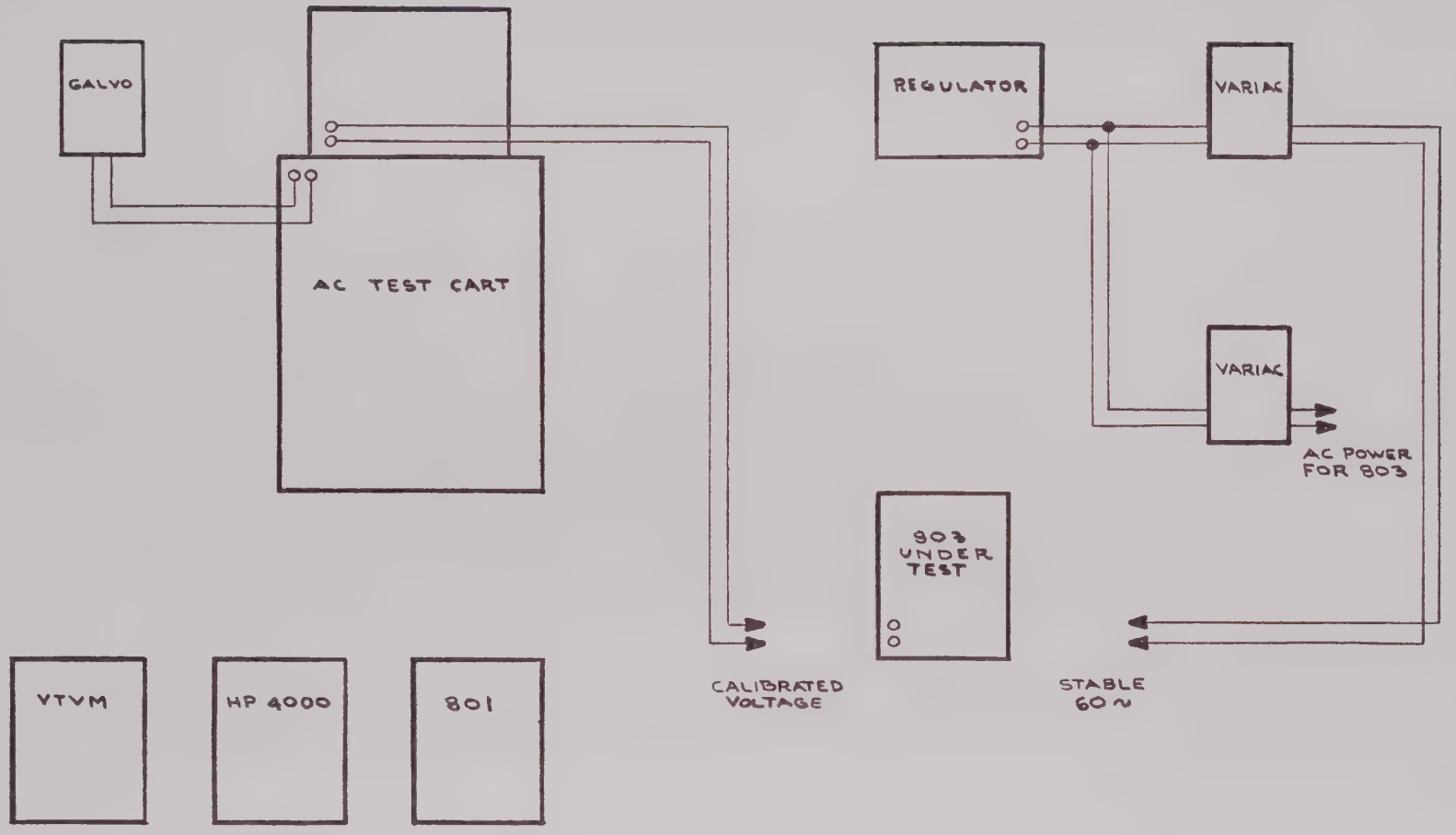
(b) Zero: Leave range switch in 5 volt ac position and turn null switch to .01V null sensitivity. Adjust converter zero (R-426) until meter indicates zero. Touch finger lightly to grid of V-401 (pin 1) and cause meter to pin violently to the right. Meter should return to within 2 small divisions of zero when finger is removed. Turn range switch to 50 volt ac position and observe that meter returns to within 2 small divisions of zero after any switching transient. Turn range switch to 5 volt ac position and repeat check of zero.

(c) Amplifier operation: Turn range switch to 500 volt ac position, null switch to VTVM position, and remove input short. Apply approximately 115 volts ac to the instrument from a stable source and obtain a differential reading. Evaluate reading to the extent that it can be determined that instrument is operating normally.

(d) Regulation: Observe instrument reading. Reading must not change by more than 100 mv as line voltage is varied between 105 and 130V.

(e) Disturbance: Observe instrument reading. Reading must not change by more than 400 mv at any time while the line voltage is abruptly varied between 105 and 130V, or at any time while the instrument is stabilizing under the new conditions.

(f) Null calibration: Continue measuring stable ac voltage at normal line voltage. With null switch in .01V null sensitivity turn Kelvin-Varley C dial one position down then one position up. Meter must deflect full scale to right and full scale left within .95% full scale to 1.05% full scale. Turn null switch to .1V null sensitivity and repeat above check with Kelvin-Varley B dial. Turn null switch to 1V null sensitivity and again repeat above check with Kelvin-Varley A dial. Remove input voltage, turn range switch to 500 volt dc position, null switch to VTVM position, and all Kelvin-Varley dials to zero.



803 AC CHECKS & CALIBRATION

MODEL 803

TUBE VOLTAGE CHART

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V1, 5Y3GT	0	1000	0	a-c 800	0	a-c 800	0	1000	-
V2, 6AQ5A	620	660	660	660	1000	1000	620	-	-
V3, 6AU6	146	150	150	150	630	280	150	-	-
V4, OA2	150	0	0	0	150	0	0	-	-
V5, 12AU7	660	500	500	500	500	500	400	420	500
V6, OG3	170	85	170	0	170	22	85	-	-
V7, OG3	85	0	85	0	85	3.6	0	-	-
V8, 12AX7	420	170	170	170	170	410	165	170	170
V201, 9-7	108	0	0	0	0	108	0	-	-
V202, OA2	150	0	0	0	150	0	0	-	-
V203, OB2	108	0	0	0	108	0	0	-	-
V204, 12AU7	108	0	6	a-c 6.3	a-c 6.3	108	0	6	a-c 6.3
V205, 6C4	101	0	a-c 6.3	a-c 6.3	100	0	6.3	-	-
V206, 12AX7	85	-.71	.15	a-c 6.3	a-c 6.3	82	-1.13	0	a-c 6.3
V301, 6X4	a-c 380	a-c 380	260	260	260	a-c 380	460	-	-
V302, 5881	260	260	460	460	245	255	255	255	-
V303, 6AW8	180	175	260	a-c 6.3	a-c 6.3	180	170	260	240
V304, 12AX7	175	86	87	0	0	175	86	87	0
V305, 6AQ5A	130	135	0	0	260	260	143	-	-
V306, 6AW8	44	42	145	a-c 6.3	a-c 6.3	44	38.5	145	143
V307, OG3	85	0	85	0	85	7.5	0	-	-
V308, OA2	0	-150	0	-150	0	0	-150	-	-
V309, OG3	0	-85	0	-85	0	-6.2	-85	-	-

TUBE VOLTAGE CHART (Cont.)

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V401, 6DK6	0	1.75	0	-6.4	106	134	0	-	-
V402, 6DK6	0	1.65	0	-6.4	98	134	0	-	-
V403, 6DK6	0	2.5	0	-6.4	150	145	0	-	-
V404, 12AU7	255	150	150	-6.8	-6.8	255	150	150	0

CONDITIONS:

1. Range switch set to 500V dc.
2. Null switch set to VTVM.
3. Line voltage at 117V, 60 cycles.
4. All measurements made from negative binding post to specified terminal.
5. All measurements made with a VTVM.
6. All voltage dials set to zero.
7. Zero adjust pots counter clockwise.

TROUBLE SHOOTING CHART

803

SYMPTOM	PROBABLE CAUSE AND/OR REMEDY
Excessive drift in the 500V reference supply as evidenced by having to re-calibrate the unit every five or ten minutes for an hour or more.	V6, V7, and/or V8 is defective. Leaky feedback capacitor C12 may cause either drift or instability.
Excessive drift in VTVM after few minutes warmup.	V204, V202, V203 defective.
Cannot calibrate instrument - meter cannot be zeroed by following re-calibration instructions.	R30 or R32 has shifted. V6 and/or V7 have aged to the point where their running voltage is too low. One of the three wirewound resistors in the standard cell sampling string has changed value. These are R33, R34 and R35. If replacement of any of these is necessary the instrument must be recalibrated. The output of the standard cell may have shifted. It should measure between 1.0190 and 1.0196 volts. Use only a Model 803 or 801, or a Leeds and Northrup type K potentiometer (or other similar potentiometer) to make this measurement. If replacement of cell is necessary, the instrument must be recalibrated. Output of the 500 volt reference supply is out of tolerance.
DC error in excess of specified values.	This is caused by either the instrument being out of calibration or by a defective resistor in the 5-dial Kelvin-Varley voltage divider.
AC error in excess of specified values only when in 50 or 500 volt AC ranges.	This may be caused by a defective component in the input attenuator circuit.
AC error in excess of specified values but no error in DC mode.	V401, V402, V403 or V404 is defective. Check voltages at sockets of tubes V401, V402, V403 and V404. Refer to Tube Voltage Chart.
AC or DC error in excess of specified values when in the 0.1 or 0.01 volt null range.	Chopper amplifier V206, 12AX7, defective. Check adjustment of R224.

803 TROUBLE SHOOTING CHART (Continued)

SYMPTOM	PROBABLE CAUSE AND/OR REMEDY
Meter needle offsets to the left as voltage dials settings are increased. NULL switch in 1 volt position, RANGE switch in 500 volts DC position, nothing connected to input posts.	This indicates leakage between grid pin 2 of V204 and ground. See Section 4-5 (7).
Meter rattle with no signal applied. This usually appears in the 0.1V and 0.01V sensitivity ranges.	V206 is microphonic. V204, V205 is defective.
Meter needle cannot be adjusted to zero in the 0.1 and 0.01 volt null ranges.	Mercury bias cell B-201 defective. V206 defective. VTVM board may require cleaning with Metriclene, M-4 solvent. Chopper input filter grossly overloaded. See discussion on page
Meter rattle in AC mode. Switches at 5 V AC, 0.01 null, R.V.'s at 0 binding posts shorted.	Measure regulated filament voltage of V-401, V402, V403, V404. If this voltage is higher than 6.2 check transistors TR-1, TR-301 and TR302. Excessive filament voltage may have damaged V401, V402, V403 and they should be replaced.

803 CHANGE SCHEDULE

CHANGE NUMBER	DESCRIPTION	STARTING SERIAL NO.
1.	7.5 ohm 5W installed on converter board across TR-1 (Decrease transistor board)	174
2.	Separate lead installed from converter board to negative binding post. Lead added from converter board ground to negative terminal	189
3.	Begin use of Teflon	189
4.	M-31 replaces M-12B	754
5.	Calibrate thru chopper circuit (easier to cal. check chopper circuit)	754
6.	Remove R-180 & R181 from plastic board and install on range switch. (AC pickup)	766
7.	Replace R-102 with 20K resistor	250
8.	Decimal and null lamps wired for DC rather than AC. R-301 & R-302 removed from converter power board lead on Pin N removed. Lead on Pin A moved to Pin N. Jumper installed on power converter board from junction of C-30 & R-325 to Pin N (AC pickup)	762
9.	Replace SC-201 & SC-202 with silicon rectifier - Remove SC-203	800
10.	Ground lead from K.V. to reference board negative rather than binding post	827
11.	Four deck null switch installed (arcing)	845
12.	Diodes across meter (pinning)	880
13.	Three-wire cord (UL)	976
14.	Ballast tube added to reference board (improve stability)	973
15.	Modified converter board zero circuit	1032
16.	10K pot added to reference board to increase calibration range	1113
17.	A series circuit of a 10K resistor on 220uuf capacitor connected between the plates of V-304 (ringing filter) Wrap standard cells with aluminum foil Tube shields on V-6 and V-7.	1488
18.	Replace 5Y3 with 5AR4	1500
19.	Recorder output - K.V. fuse added	1724

803 CHANGE SCHEDULE (CONTINUED)

CHANGE NUMBER	DESCRIPTION	STARTING SERIAL NO.
20.	Replace R-102 with 15K resistor	1900
21.	2K pot exchange for the 1K CAL ADJ pot (greater cal. range)	2170
22.	Replace TR-1 with a 2N258	2110
23.	Replace C-1 and C-2 with a series of 3 - 20uf capacitors each paralleled with a 220K resistor. This circuit replaces C-1 and C-2	2200
24.	Add C-6B, 82uuf in parallel with C-6 and C-6A CT-36	2234
	VOID Change C-9 to 10uf (fiber glass boards only)	
25.	Calibrated to = 10 KC	2599

803 CALIBRATION REPORT

SERIAL NUMBER		TEST LIMITS	HOT	COLD
A. DC Calibration - Date & Time		xxx		
		20 mv Hot		
1. Cal error 500V		+70 mv Cold		
2. Read. error 49.910V		10 mv		
3. Read. error 50.00V		10 mv		
4. Cal error 49.9910V		±7.5 mv	set to 0	
5 Read. error 4.9910V		1 mv		
6. Read. error 5.000V		1 mv		
7. Cal error 4.99910V		±0.75 mv	set to 0	
8. Read. error 0.49910V		0.2 mv		
9. Cal error 0.499910V		±0.2 mv	set to 0	
10. Std. cell	at 5V	0.03%		
11. Hg cell	at 5V	0.03%		
12. Hg cell - std. cell	at 5V	0.03%		
13. Hg cell - std. cell	at 5V	0.03%		
14. Hg cell - std. cell	at 0.5V	0.03%		
15. Std. cell	at 50V	0.03%		
B. AC Calibration - Date & Time		xxx		
1. 5V 400 CPS	5V	0 to +5 mv		
	3V	± 6 mv		
	1V	± 2 mv		
	0 5V	± 1 mv		
2. 5V 5000 CPS	5V	0 to +5 mv		
	3V	± 6 mv		
	1V	± 2 mv		
	0.5V	± 1 mv		
3. 5V 30 CPS	5V	± 10 mv		
	3V	± 6 mv		
	1V	± 2 mv		
	0.5V	± 2 mv		
4. 50V 400 CPS	50V	0 to +50 mv		
	30V	± 60 mv		
	10V	± 20 mv		
5. 50V 5000 CPS	50V	0 to +50 mv		
	30V	60 mv		
	10V	20 mv		
6. 50V 30 CPS	50V	100 mv		
	30V	60 mv		
	10V	20 mv		
7. 500V 400 CPS	500V	0 to +500 mv		
	300V	600 mv		
	100V	200 mv		
8. 500V 5000 CPS	500V	0 to +500 mv		
	300V	600 mv		
	100V	200 mv		
9. NWT Test		xxx		

Std. Cell Box #_____

Chopper

Hot	Cold
%	%

VTVM

Hot	Cold

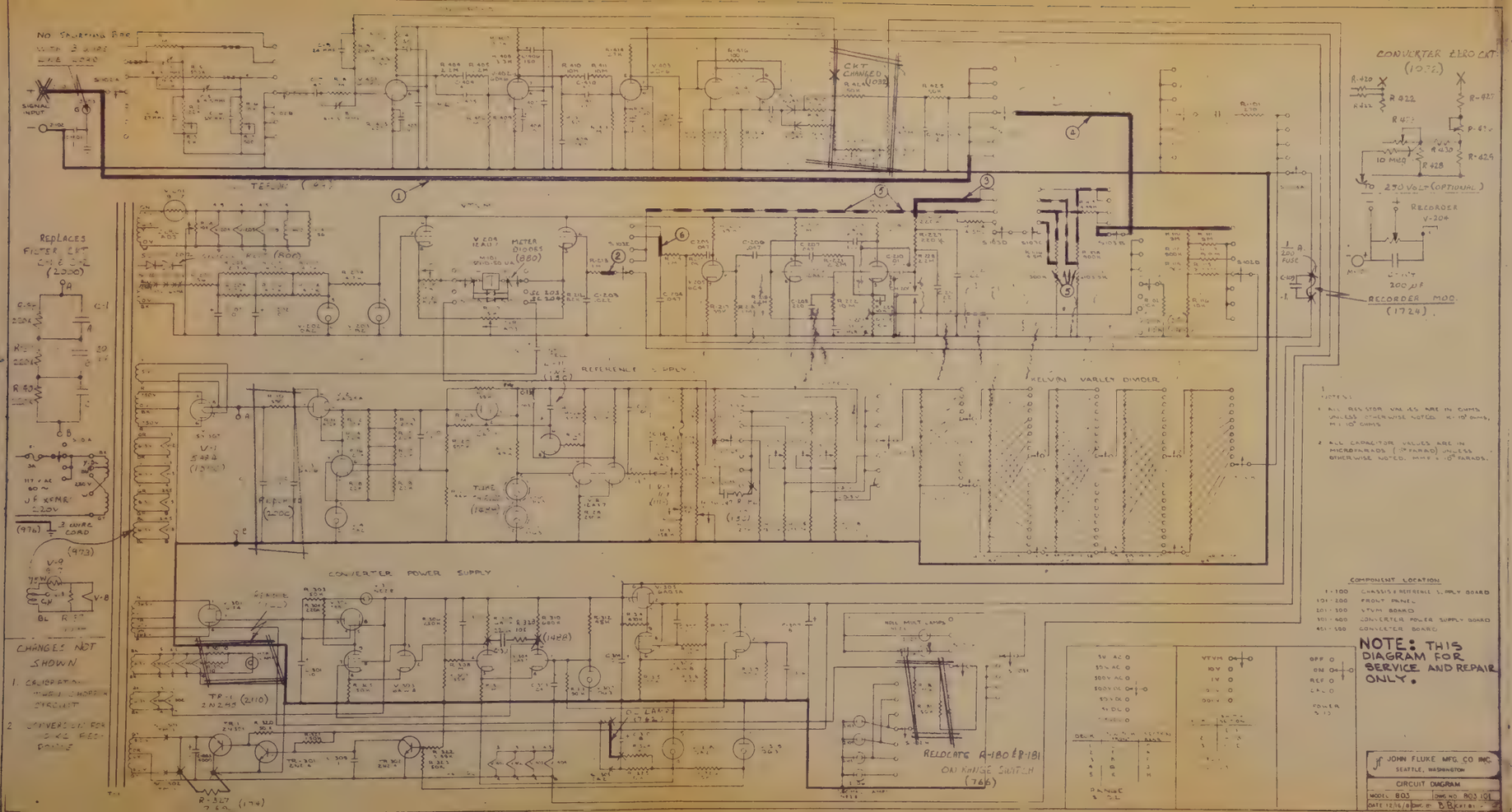
KV						

Recorder Output ☐

D.C. CAL.

A.C. CAL.

D. Pre-Cal Checks 803	Date					
1. Ref. Supply	Ser#					
a. Ebb	900-960V					
b. Eo pre-reg.	600-640V					
c. eo ref.	8 mv					
d. Emin ref.	100V					
e. ec V-5	-2V					
h. Regulation (105-130V)	25 mv					
i. 1V Sample	1V					
j. Eo ref.	500V					
2. VTVM Supply	XXX					
c. Eo pre-reg.	145-155V					
e. Eo	105-111V					
f. eo	2 mv					
g. Emin	100V					
h. Regulation (105-130V)	20 mv					
i. Fil reg. (105-130V)	800 mv					
3. Conv. Supply	XXX					
a. Eo 250V	245-255V					
b. eo 250V	10 mv					
c. Emin 250V	100V					
d. Reg. 250V (105-130)	50 mv					
e. 250V (105-130V)	100 mv					
f. Eo 140V	135-145V					
g. eo 140V	10 mv					
h. Emin 140V	100 mv					
i. Reg. 140V (105-130V)	300 mv					
j. 140V (105-130V)	1V					
k. Eo -6.1V	6.0 - 6.3V					
l. eo -6.1V	30 mv					
m. Emin -6.1V	100V					
n. Reg. -6.1V (105-130V)	10 mv					
o. -6.1V (105-130V)	10 mv					
4. VTVM Circuits	XXX					
a. Zero Stability	2 sd					
b. Grid Current	½ sd					
c. Sensitivity	2 sd					
d. Meter Stickiness	½ sd					
e. Meter Linearity	1-½ sd					
5. Range Res. & K-V	XXX					
a. 50V	2 sd					
b. 5V	2 sd					
c. .5V	2 sd					
d. Leakage	½ sd					
6. Chopper Circuits	XXX					
a. Null Sensitivity	2 sd					
b. Offset - open	½ sd					
c. Offset - short	2 sd					
d. Zero Stability	2 sd					
e. Leakage	½ sd					
f. Gain	-1 sd					
g. Adjust Range Pots						
7. Converter Circuits	XXX					
a. Stability						
b. Zero	2 sd					
c. Amplifier						
d. Regulation (105-130V)	.1V					
e. (105-130V)	.4V					
f. Null Calibration	A .95-1.05 FS					
	B .95-1.05 FS					
	C .95-1.05 FS					



INFORMATION ABOUT THIS SCHEMATIC

1. This schematic is basically the circuit for the earliest 803 voltmeters.

   Most of the circuit changes which have taken place in this instrument are shown either in the border or drawn into the schematic itself. Changes to the schematic are indicated with a small cross mark, X, at the junctions of the components or circuits affected.

   The serial number when the change was effected is shown in parenthesis in the vicinity of the change.

2. To cure leakage the following procedure should be used:

   (Leakage is defined as the shift in meter reading from zero when comparing 00.000 on the Kelvin-Varley to 49.9910 in the 50 volt range. The shift as observed on the meter should be less than $\frac{1}{4}$ small scale division.)

   A. Replace or remove and wash J-101 marked ⅄ on the schematic.

   B. Replace leads marked (1) (2) (3) (4) with teflon insulated wire. Their significance toward the leakage cure is in numerical sequence.

   C. If leakage persists replace dotted leads (5) with teflon.

3. To cure offset (Defined as shift in zero when switching from .1 to .01 in the null mode. The shift should be less than one-half ($\frac{1}{2}$) small scale division).

   A. Offset is eliminated by replacing lead (6) with teflon.

   B. If offset persists remove R-180 and R-181 from the resistor board located behind the K-V switches. Remount R-180 and R-181 on switch S-102P and S-102K respectively.

FLUKE

TECHNICAL DATA

825A VOLTMETER

MODEL 825A PRECISION DIFFERENTIAL DC VOLTMETER

FEATURES

0.025% Accuracy

5 Microvolt Resolution

Infinite Input Resistance at Null over entire 0 - 500 Volt Range

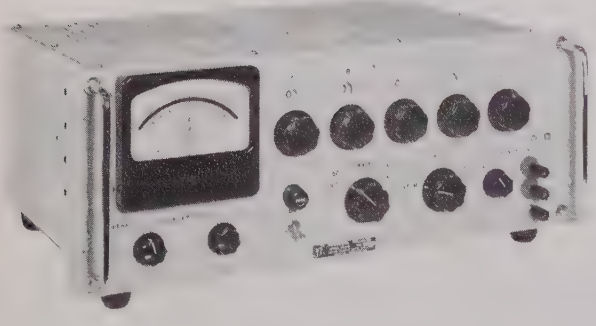
Standard Cell Reference

Polarity Switch

Taut-band Suspension Meter

In-Line Readout with Automatic Lighted Decimal

No Zero Controls



Model 825A, the new FLUKE differential voltmeter, provides ±0.025% accuracy and infinite input resistance at null over the entire 500 volt range.

As additional features, the Model 825A includes a polarity switch which enables the operator to make negative or positive voltage measurements with equal convenience and a 0 - 25 MV recorder output which makes the Model 825A particularly useful for monitoring the stability of virtually any DC source.

Model 825A presents the value of the unknown voltage on an in-line five decade digital readout with automatic illuminated decimal. As another important feature, unique circuit design makes the Model 825A virtually impossible to damage by accidental overload.

The basic elements of the 825A are a standard cell used as an internal reference, a stable 500 volt reference source, a precision five-dial Kelvin-Varley voltage divider, and a chopper stabilized null detector. If required, the Model 825A may be supplied with a zener reference in place of the standard cell. To further increase versatility, the 825A is designed to be used with the FLUKE Model 80 Series Precision Voltage Dividers in order to accurately measure voltages to 30 KV.

As an example of the exceptional versatility of the Model 825A, a few of its many applications are explained below:

Calibration, testing and stability measurements of regulated power supplies.

Instrument calibration.

DC voltage measurements in high resistance circuits as well as low resistance sources including photocells, standard cells, computers, power supplies, batteries, tube circuits, thermocouples, storage devices, etc. All of these measurements may be made with accuracy and without source loading error.

As a substitute for conventional potentiometers, particularly for voltages above 1.6 v where the loading effect of voltage attenuators cannot be tolerated.

SPECIFICATIONS

AS A PRECISION POTENTIOMETER

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING	DIAL RESOLUTION	INPUT RESISTANCE PER VOLT OF INPUT VOLTAGE AT NULL	1% OFF NULL
50-500	1-0-1	0.01 v	Infinite	1,000 Meg
5-50	0.1-0-0.1	0.001 v	Infinite	10,000 Meg
0.5-5	0.01-0-0.01	0.0001 v	Infinite	100,000 Meg
0-0.5	0.001-0-0.001	0.00001 v	Infinite	100,000 Meg

*Any null range may be used at any input voltage; recommended ranges are those most useful.

ACCURACY: ±0.025% of input voltage from 0.1 v to 500 v. ±0.025% of input voltage plus 25 microvolts, below 0.1 v.

These accuracies are obtained when recommended ranges are used.

AS A CONVENTIONAL VACUUM TUBE VOLTMETER

VOLTAGE RANGES	INPUT RESISTANCE	SCALE DEFLECTION
0 to ±500 v	50 Meg.	500-0-500
0 to ±50 v	50 Meg.	50-0-50
0 to ±10 v*	10 Meg.	10-0-10
0 to ±5 v	50 Meg.	5-0-5
0 to ±1 v*	10 Meg.	1-0-1
0 to ±0.5 v	50 Meg.	0.5-0-0.5
0 to ±0.1 v*	10 Meg.	0.1-0-0.1
0 to ±0.01 v*	10 Meg.	0.01-0-0.01
0 to ±0.001 v*	1 Meg.	0.001-0-0.001

ACCURACY: 3% on all ranges. *These ranges obtained by setting NULL switch to desired sensitivity with the 5 voltage dials set to 0.

STABILITY OF REFERENCE SUPPLY: 0.01% for ±10% change in line voltage (105 v to 130 v). 0.01% per hour after warmup.

STABILITY OF METER ZERO: 1% of full scale for ±10% change in line voltage.

CALIBRATION: 500 volt reference supply calibrated against built-in standard cell.

INPUT POWER: 105 - 130 volts, 60 cps, 60 watts.

DIMENSIONS: 9-3/4" wide x 13" high x 14" deep, standard model. 19" wide x 7" high x 14" deep, rack mounting model.

FINISH AND WEIGHT: Smooth grey baked enamel. Grey baked wrinkle case. Cabinet model--25 lbs. Rack mounting model--22 lbs.

PRICE: Cabinet model--$555.00; rack model--$575.00. All prices f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U.S.A.

Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Hails Lake TLX 852

ℱ MODEL 825A TEST PROCEDURE

NOTE: The OG3 reference tube must be aged for at least 150 hours before installation in the 825A.

TURN ON

VISUAL INSPECTION

1. Check that PCB's and "ceramic type" switches have some sort of moisture treating.

   Important: Mechanically zero meter.

2. Leakage Resistance - Measure resistance between negative binding post and chassis. Must be infinite as read on a Simpson meter. Set RANGE switch to 500V, NULL switch to VTVM, and K-V dials to 0, Polarity switch to +.

3. Input Power - Set power variac to 0 and turn instrument on. Slowly increase variac setting while monitoring input power. Increase variac setting to 117V. Input power should be 45-70W. Monitor input power while continuing preliminary checks and be alert for smoke or other evidence of trouble. Increase variac setting to 130V and check for any failure. Input power should not exceed 70W (or 75W for the 825A/G). Return variac to 117V for remaining checks.

4. Voltage Measurements (With Respect to Negative Binding Post as 117V Line) -
   Reference Supply - High Voltage, Ebb, voltage at pins 7 and 9 of V102 should be 680-730V, dc.

5. 500V Reference - Voltage at pin 3 of V102 should be 470-530V, dc.

VTVM Supplies:

6. Voltage at pin 5 of V204 should be 140-168V.

7. Voltage across pins 4 and 5 of V202 should be 11.3 - 12.3V.

8. Bake - Operate instrument on normal line voltage for not less than 24 hours.

PRE-CALIBRATION CHECKS

NOTE: All measurements are with respect to negative binding post

unless otherwise stated and in the positive polarity. Start each check with normal line voltage (117V).

Reference Supply -

9. 500V Calibration - With the ADJ. CAL. pot in its center of rotation adjust R121 until reference is 500.0 ±.2V.

10. Reference voltage ripple, eo - Ripple voltage at V102 of pin 3 should not exceed 8 mv ac.

11. Reference Supply Regulation - Observe dc 500V reference voltage at V102 pin 3. Voltage must not change by more than 50 mv dc as line voltage is varied between 104-130V. At the same time observe the filament voltage on V102. Filament regulation should be .4V or less. Between high and low line the voltage should be between 5.5V and 6.6V.

    Return line voltage to 117V and monitor voltage carefully for 30 seconds while lightly tapping instrument. Voltage must not change erratically.

Null Detector

12. +Eo Regulation - Observe voltage at V204 pin 5. Voltage must not change by more than 2V as line voltage is varied between 104 and 130V.

13. Ripple, +eo - Ripple voltage at V204 pin 5 should not exceed 15 mv.

14. Ef - Filament Regulation - Observe voltage across V202, pins 4 and 5. Supply must regulate within 200 mv as line is varied from 104-130V. Ripple should be less than 5 mv.

15. VTVM Zero Adjust - Check mechanical meter zero then place instrument in case. At 117V line with chassis ground connected to line ground, adjust R233 for a good null on the meter.

16. Rattle - Observe meter closely. Random excursions of meter needle should be less than 1/4 small division. Critical components - chopper, chopper drive unit (beat on meter), and cleanliness.

17. VTVM Offset Check - With K-V dialed to zero, turn NULL knob from VTVM to 10V - 1V - .1V - .01V - .001V. Meter should not deflect from null by more than 1/4 small division.

18. VTVM Zero Stability - With null switch in VTVM position, vary line from 104-130V. Meter needle must return to within 1/4 small division of its original reading.

19. VTVM Sensitivity - Turn NULL switch to VTVM position. Apply 500 volts to the instrument and adjust meter sensitivity. (R222) for full scale right deflection. Reverse the polarity of the 500V input and deflection to the left must be within 1/2 small division of full scale.

20. Meter Linearity - Apply voltages from 0 to 500V to the instrument in 100V steps. Meter must read accurately to within 3/4 small division at all times. Reverse polarity and repeat all readings.

21. Null Sensitivity Check - Set instrument to 500V Range, K-V to zero and short input. Turn null switch to 10V position and turn K-V "B" dial to 1, meter needle must deflect to within 1 small division of full scale.

22. Recorder Output Check - Measure mercury cell on .01 NULL range. Plug in an 801 or 801H into the recorder output. Turn K-V "C" dial of the unit under test and observe on the 801 (on .1V null) that the 801 meter follows the deviation on the instrument under test.

23. Polarity Reversal - Null out the voltage of the mercury cell on the .001V range. Reverse polarity - reading should be within 20 uv.

24. VTVM Leakage - Turn RANGE switch to 500V, NULL switch to .1V null sensitivity, and check meter zero with input posts open. Turn K-V "A" dial slowly to 4 and "B" dial slowly to 9. Meter offset must not exceed 2 small divisions.

Final Calibration

NOTE: Check mechanical and electrical zero.

25. Calibrate VTVM - This is mainly a cold check of the VTVM calibration.

26. Calibrate 500V - With instrument in the 500V range, dial up 499.910 on K-V, apply a voltage of 500 ±.01V. Next null out the 500V on the .1V null range by adjusting the external calibrate pot. While at null turn the Operate-Calibrate switch to Calibrate, then carefully adjust R318 to null on the meter.

27. Check 50V VTVM - Using the ℱ 525A - Put 50V into input and check accuracy of 50V VTVM position. Meter needle must deflect within 3/4 small division.

28. Calibrate 49.9910. Null out 50V in the .01 null range by adjusting R323.

29. Check 5V - VTVM.

30. Calibrate 4.99910.

31. Check .5V - VTVM.

32. Calibrate .499910.

33. In the 500V Range, null out 100V on the .1V null range by dialing 100.00 and 99.910. Reading should be within ±10 mv. (.01%)

34. In the 5V Range, null out 1V on the .001V null range. Reading should be within 140 uv. (.014%).

35. In the 5V Range, null out .25555 volts. Reading should be within 50 uv. (.020%).

36. In the .5V Range, null out .25555 volts. Reading should be within 40 uv. (.016%).

37. In the .5V Range measure .1V. Reading must be within 20 uv. (.020%).

1/24/62

825A TEST REPORT

Serial Number: _____

Time & Date: _____

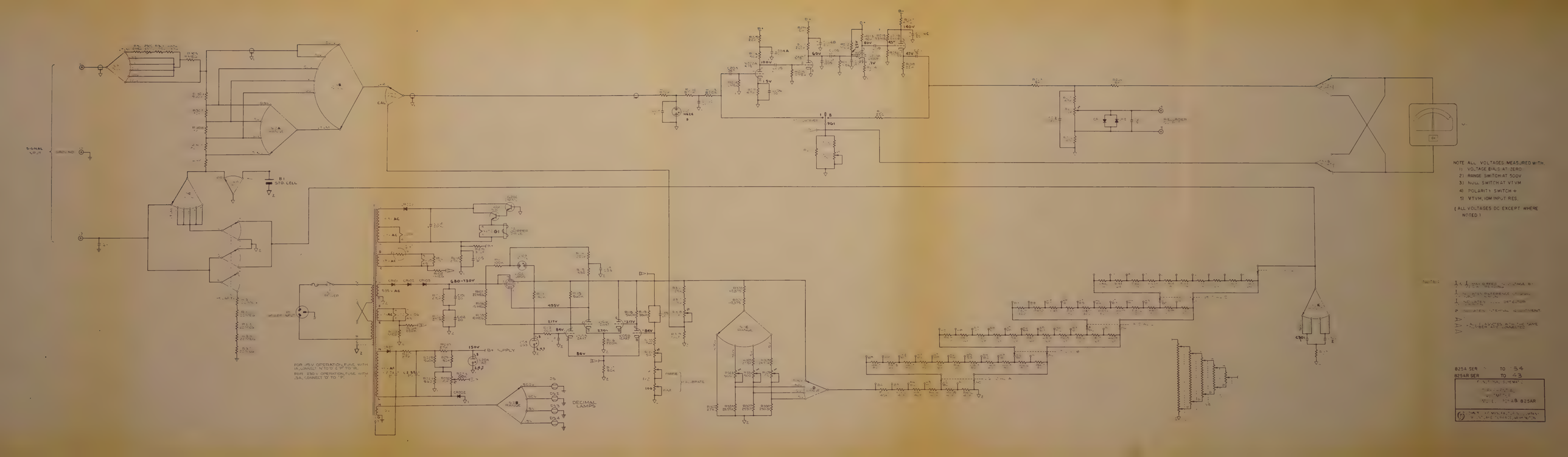
TURN ON	Tolerance		FINAL CALIBRATION Date & Time	Test Limits	Hot	Cold
1. Visual Inspection (Chk meter zero)			25. 500V VTVM	1-t 1 sd	Set to 0	
2. Leakage Resistance			26. Cal 500V	20 mv hot	Set to 0	*
3. Input Power	45-60 w			40 mv cold		*
4. Ebb, high voltage at 117V	680-730V		27. 50V VTVM	1-t 3/4 sd		
5. 500V reference	470-530V		28. Cal 49.9910V	±4 mv	Set to 0	*
6. +Eo, VTVM	140-168V		29. 5V VTVM	1-t 3/4 sd		
7. Ef, VTVM Filaments	11.3-12.3V		30. Cal 4.99910V	±.4 mv	Set to 0	*
8. Bake			31. .5V VTVM	1-t 3/4 sd		
			32. Cal .499910V	±50 uv	Set to 0	*
PRE-CAL			33. 100.00V & 99.910V	±10 mv		*
			34. 1.000V on 5V	±140 uv		*
9. 500V Calibration			35. .25500V on 5V	±50 uv		*
10. eo, Reference ripple voltage	1-t 8 mv ac		36. .25500V on .5V	±40 uv		*
11. Ref. stability at 104-130 (Chk 9-7)	1-t 50 mv *		37. .10000 on .5V	±20 uv		*
12. +Eo, VTVM regulation 104-130	1-t 2V		38. Std. Cell/Reading	1.019	1.019	
13. +Eo, VTVM ripple	1-t 15 mv ac					
14. Ef, VTVM Filament Reg.	1-t 200 mv					
15. VTVM zero adjust (Chk mech. zero)	Set to 0					
16. Rattle	1-t 1/4 sd					
17. VTVM offset check (Chk meter zero)	1-t 1/4 sd					
18. VTVM zero stab. 104-130	1-t 1/4 sd *					
19. VTVM Calibration	1-t 1/2 sd					
20. Meter Linearity	1-t 3/4 sd					
21. Null Sens. Chk.	1-t 1 sd					
22. Recorder Output Check						
23. Polarity Reversal - Hg Cell	1-t 20 uv *					
24. VTVM Leakage	1-t 1/4 sd					

*Record Actual Test Results

Std. Cell Box No.: _____

Technician: _____

KV						


SIGNAL INPUT
GROUND
B1
STD. CELL
CAL
NULL
DECIMAL LAMPS
FOR 115V. OPERATION, FUSE WITH 1A. (SMALL) X TO 'O' & 'P' TO 'R'.
FOR 230 V. OPERATION, FUSE WITH .5A., CONNECT 'O' TO 'P'.
180V
80V
45V
4V
100V
15V
3V
495V
84V
230V
150V
NOTE ALL VOLTAGES MEASURED WITH
1) VOLTAGE BALS AT ZERO
2) RANGE SWITCH AT 500V
3) NULL SWITCH AT VTVM
4) POLARITY SWITCH +
5) VTVM, 10M INPUT RES.
(ALL VOLTAGES DC EXCEPT WHERE NOTED)
825A SER TO 54
825AR SER TO 53
MODEL 825A & 825AR

FLUKE

TECHNICAL DATA

102 VAW METER

Measures . . . Volts . . . Amperes . . . Watts

FEATURES

- 20 cps to 100 KC
- 10% and Unity Power Factor Ranges
- 1.5 to 600 Volts AC
- 0.0015 to 30 Amperes
- Negligible Circuit Burden
- True Electrodynamometer Action

DESCRIPTION

The Model 102 VAW Meter is an ideal instrument for measuring voltage (V), current (A), and power (W) over a wide frequency range. The Model 102 allows direct reading of voltage, current and power on a linear meter scale. Because of its high sensitivity, it is capable of reading power from microwatts to kilowatts. Because of its high input impedance and low shunt drop it produces negligible insertion effects on the circuit under test. Power readings are inherently without waveform error for all frequency components within the specified frequency range.

APPLICATION

The VAW Meter is ideally suited to measure the true power consumed by a wide variety of loads. This includes both linear and non-linear elements such as servo components, transformers, rectifiers--substantially any power consuming circuit configuration.

In addition, the instrument will be found exceptionally useful in measuring amplifier output power into the actual amplifier load; will, in fact, obsolete the substitution method of utilizing resistance loading for estimating amplifier power output.

VOLTAGE (FULL-SCALE)	CURRENT (FULL-SCALE)	POWER	POWER FACTOR RANGE	FREQUENCY RESPONSE	ACCURACY	INPUT IMPEDANCE
1.5 - 600V	1.5 ma-30A	225 uw to 18 KW	1.0	20 cps - 100 KC	3%	1 megohm 25 uufd
			0.1	20 cps - 20 KC	3%	
				20 KC - 40 KC	5%	

GENERAL SPECIFICATIONS

VOLTAGE RANGES: 1.5, 3, 6, 15, 30, 60, 150, 300, 600 volts RMS full-scale, selected by voltage range switch on front panel.

CURRENT RANGES: 0.0015, 0.003, 0.006, 0.015, 0.03, 0.06, 0.15, 0.3, 0.6, 1.5, 3, 6, 15, 30 RMS amperes full-scale, selected by plugging in shunts on the front panel.

POWER RANGES: Wattmeter readings are direct readings taking into account the "Power Factor" switch setting of either 0.1 or 1. With the "Power Factor" switch set at 1 the wattmeter reads VA cos ϕ; with the switch set at 0.1 the wattmeter reads 0.1 VA cos ϕ. Consequently, the full-scale watts range is from 225 microwatts to 18 kilowatts, or the product of any full-scale current, any full-scale voltage and either 0.1 or 1.

SHUNT DROP: 45 millivolts at full-scale current.

METER SCALES: Voltage, current and power are read on the same meter scales, with the selection of the desired quantity being determined by positioning the "VAW" switch.

INPUT VOLTAGE: 117/220/234 volts, 50 - 60 cps.

ACCESSORIES: Supplied with one shunt of any value listed above under "Current Ranges" as selected by the purchaser. Additional shunts may be purchased as extra equipment.

FINISH: Smooth gray baked enamel on front panel. Front panel machine engraved.

DIMENSIONS: 13" wide, 10" high, 12" deep, exclusive of handles and knobs.

WEIGHT: Net weight, 35 pounds, shipping weight, 52 pounds.

PRICE: $555.00 f.o.b. factory, Mountlake Terrace, Washington, with one shunt of listed rating. Additional shunts are $20.00 each, f.o.b. factory.

The right is reserved without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice

7-31-61-A

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 102 VAW METER

CALIBRATION PROCEDURE

Prepared by: George Gunby & Owen Green
Engineering Dept.

Revised
October, 1959

EQUIPMENT: H-P 200CD Oscillator
H-P 400L Voltmeter
Power Amplifier
.006A Calibration Shunt
Precision Resistors and Mica Capacitors called for in following instructions

ABBREVIATIONS: VAW = Volts, Amps., Watts Selector Switch
PF = Power Factor Switch
V = Volts Range Switch

CHECKOUT PROCEDURE

1. Visual Inspection -
   A. All tubes in proper sockets.
   B. Check solder connections - tube sockets and terminal boards.
   C. Check mechanical zero of meter.

2. Put 0 - 750 ma d-c ammeter in series with red tracer (-) and pin 2 (+) of V14 (5Y3).
   Connect nothing to H, G, or L posts - no shunt.
   Set V to 6 v.
   Set PF to 1.
   Set VAW to V or A.
   Turn power on - ammeter should read 110 ma ±15 ma. If okay, remove meter and solder lead in place.

3. Check B+ (pins 3 & 6 of V13). Set to 250 v via P8.
   Check ripple and regulation for 100-130 v line.
   Ripple - 6 mv maximum.
   Regulation - 1.5 v maximum.

4. Check filament voltages. Set 117 v line.
   V5 (pins 2 & 7) = 6.3 v ±.2 v.
   V8 (pins 2 & 7) = 6.3 v ±.2 v.
   Vary line voltage - V8 should stay within 6.0 - 7.1 v.

5. Check electrode potentials
   Pentodes (V2, V4, V5, V7) should read 100-150 v plate and 85-115 v screen.
   V6 should read 150-200 v plate,
   60-90 v screen
   Indicated bias points should read -1.6 v ±0.2 v.

For V1 (6SN7) pin 5 = 160 ± 30 v
pin 2 = 130 ± 30 v
pin 6 = 5.7 ± 1 v

For V9 (6SN7) pin 5 = 210 ± 20 v
pin 2 = 110 ± 20 v
pin 6 = 9 ± 1 v

For V3 & V8 pin 8 = 22 ± 2 v

6. Plug in .006 amp. shunt.
Turn VAW switch to V - meter should read 0.
Turn VAW switch to A - meter should read 0.

If any deflection, check for oscillation at pin 4 of V9 with oscilloscope (input grid of VTVM tube).

7. Full scale V and A.
Set V to 6 v.
Put 1 k across H and G.
Set VAW to V.
Connect H-P400L from L to G.
Set osc. ampl. so that 400L reads 45 mv.

Adjust P2 so that meter indicates fs volts.

Set VAW to A.

Adjust P1 so that meter indicates fs amps.

8. W zero knob range.

Set VAW switch to W. Select V3 and V8 (6V6) to effect meter zero with W zero knob somewhere in its range. Then trim R12 or R32 (150 k) to center W zero knob. Use nothing smaller than 220 k.

9. W scale zero for fs V, zero A.

Set PF to .1.
Set VAW to W and set zero watts.
Set VAW to V.
Connect osc. to H and G and nothing to H and L.
Set osc. to give 80 to 100% fs V.
Switch VAW to W; it should read zero.

If not, adjust P3. If adjustment cannot be made with P3, shunt R54 or R55 to bring P3 in range. Value may be from 0 to 10 k.

10. W Scale zero for fs A, zero V.

Set osc. amplitude to zero.
Short H to G.
Connect osc. in series with 1 k resistor to H and L.
Set VAW to A.
Adjust osc. to give 80-100% fs A.
Switch VAW to W, it should read zero.

If not, trim either R117 or R118. Value may be from 1 mΩ to 10 mΩ.

11. Repeat 9 and 10 above to be sure adjustments have been correctly made.

12. Full scale W, PF = 1.

Set PF to 1.
Connect osc. to H and G.
Put 1 k across H and L.
Connect H-P400L from L to G.
Set osc. amp. so that 400L reads 45 mv.
Set VAW to W.
Adjust P4 for fs watts. It may be necessary to trim R52 to effect adjustment. (Shunt R52 with 100Ω)

13. 6V6 linearity.

Set PF to .1.
Zero W scale.
Set VAW to A.
Set osc. to 2 kc.
Connect osc. to H and G posts.
Connect series load of .1 mfd and 67.5Ω to H and L posts.
Increase gain of osc. to give full scale A reading.
Set VAW to W and note reading.
Turn osc. to zero, change .1 mfd to .4 mfd, switch VAW to A.
Increase gain of osc. to give full scale A reading.
Set VAW to W. Reading should be the same as with the .1 mfd capacitor.

NOTE 1: If the two W readings in 13 above are not identical, replace one or both of the 6V6's, and repeat steps 8 thru 13.

NOTE 2: If it appears that no combination of 6V6's will cause the W readings to coincide, an abnormal circuit condition is indicated. This may be due to unusual non-linearities in the other amplifier tubes, faulty components, or, rarely, an unstable multiplier unit (S-can). There is no reason to suspect improper functioning of the multiplier unit, however, unless all other possible causes of trouble have been eliminated.

14. Full scale W, PF = .1

Set PF to .1.
Connect load of .1 mfd in series with 67.5Ω from H to L.
Zero W scale.
Set VAW to W - it should read 75% fs (27 for fs of 36).

Adjust P6 for 75% fs. If necessary, shunt R53 with 100Ω to effect adjustment.

As a check, change load to .4 mfd in series with 17.5Ω.
Set VAW to A.
Adjust osc. for fs A.
Set VAW to W - should read 25% fs (9 for fs of 36).
Set V to 3V - W should read 50% fs.
Set V to 1.5V - W should read 100% fs.

15. Checkout procedure is complete. Remove shunt and other calibrating equipment, plug 102 in to cook for 40 hours before final calibration.

FINAL CALIBRATION PROCEDURE

(Allow 15 minute warmup.)

1. Repeat steps 7 thru 13 of checkout procedure.

2. W zero for fs V, no A and fs A, no V, 20 kc.

Repeat steps 9 and 10 in Checkout Procedure, but with osc. set for 20 kc.
Do not disturb adjustments made in steps 9 and 10.

If there is more than 1% of fs shift in W zero, some tube in the amplifier chain needs replacing.

3. W reading at 20 kc.

Set osc. to 20 kc and connect to H and G.
Connect load of .01 mfd in series with 67.5Ω across H and L.
Set PF to .1.
Switch VAW to A.
Connect H-P400L across .006A shunt.
Set osc. output to give .006A. (fs)
Set VAW to W - should read 75% fs.

If not, trim R22 with 7-35 mmfd. (C50)

4. Reduce osc. output to zero.

Set V to 1.5V.
Change load to .04 mfd in series with 17.5Ω.
Set VAW to A, adjust osc. for fs A.
Switch VAW to W, should read 100% fs.

If not, trim R103 with 15-100 mmfd.

Switch V to 3V, W should read 50% fs.

5. 20 cps W zero check.

Set osc. amplitude to zero, freq. to 20 cps, and connect to H and G.
Connect load of 5 mfd.
Set V to 6V.
Set PF to .1.
Switch VAW to A.
Increase osc. amplitude to give .006 A.
Switch VAW to W - should read 7.5% fs.

If not, increase or decrease R14 - value should be 1 m - 10 m. If correct results not obtained, check coupling capacitors in amp., particularly C17 which may be increased if necessary.

Check voltage ranges of 15-600V.
Use power amplifier.

6. Set PF to 1.
Set VAW to V.
Set osc. to 2 kc. Connect power amplifier output to H and G.

A. Switch V to 600V.
Change load to 50 k.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 300V on 600V scale.

B. Switch V to 300V.
Check that V reads 300V on 300V scale.

C. Decrease osc. amplitude so that H-P400L reads 22.5 mv.
Switch V to 150V.
Check that V reads 150V on 150V scale.

D. Set V to 15V.
Use load of 5 k.
Connect H-P400L Across shunt.
Set osc. amplitude so that H-P400L reads 22.5 mv.

Check that V reads full scale.

E. Switch V to 30V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads full scale.

F. Switch V to 60V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 30V on the 60V scale.

.1 PF VOLTAGE ADJUSTMENTS

7. A. Set V to 60V.
B. Set VAW to A.
C. Set PF to .1.
D. Set osc. amplitude to 0, f to 20 kc, power amplifier output to H and G.
E. Load H and L with .0015 mfd.
F. Set osc. for FSA.
G. Set VAW to W.

W should read .75% fs (1/4 division) - Adjust C41

8. Set V to 30V.
Repeat B, C, D above.
Load H and L with .0025 mfd.
Set osc. for fs A.
Set VAW to W.

W should read 1.5% of fs (1/2 division) - Adjust C47 - May require padding with 39 mmf.

9. Set V to 15V.
Load H and L with .004 mfd (.0015 + .0025)
Set osc. for fs A. W should read 3% of fs - Adjust C46.

10. Set V to 600V.
Load H and L with .00015 mfd.
Set osc. for fs A.

W should read 0 - Adjust C40 (C45 may need to be reduced)

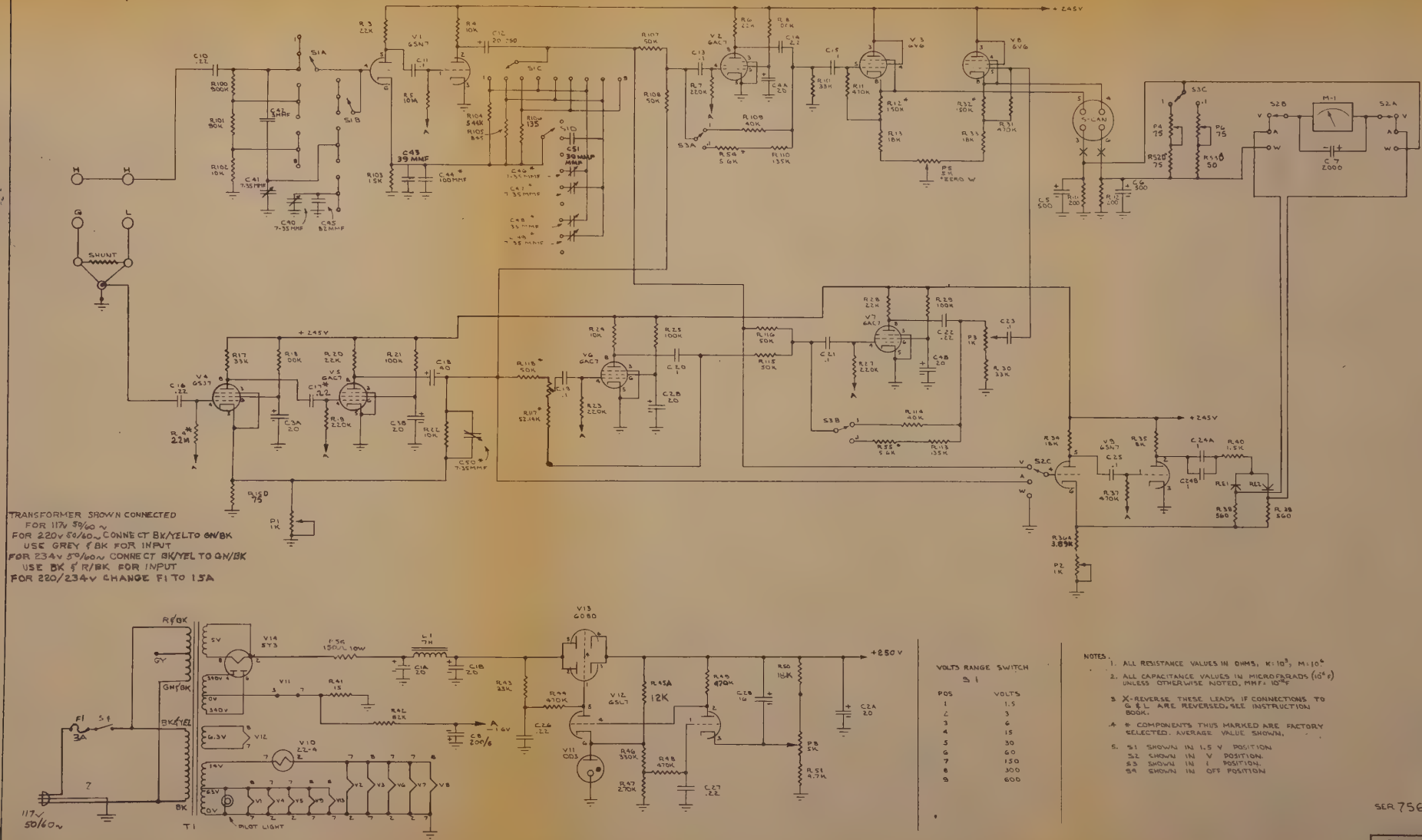
11. Set V to 300V.
Load H and L with .00025 mfd.
Set osc. for fs A.

W should read 0. Adjust C49.

12. Set V to 150V.
Load H and L with .0004 mfd (.00015 + .00025)
Set osc. for fs A.

W should read 0 - Adjust C48 (may require 82 mmf from G to C48)

CALIBRATION COMPLETE



VOLTS RANGE SWITCH S1

POS	VOLTS
1	1.5
2	3
3	6
4	15
5	30
6	60
7	150
8	300
9	600

NOTES.

1. ALL RESISTANCE VALUES IN OHMS, K=10^3, M=10^6
2. ALL CAPACITANCE VALUES IN MICROFARADS (10^{-6}) UNLESS OTHERWISE NOTED. MMF= 10^{-12}F
3. X-REVERSE THESE LEADS IF CONNECTIONS TO G & L ARE REVERSED. SEE INSTRUCTION BOOK.
4. * COMPONENTS THUS MARKED ARE FACTORY SELECTED. AVERAGE VALUE SHOWN.
5. S1 SHOWN IN 1.5 V POSITION
   S2 SHOWN IN V POSITION.
   S3 SHOWN IN ~ POSITION.
   S4 SHOWN IN OFF POSITION

SER 756 & ABOVE

JOHN FLUKE MFG CO INC
SEATTLE, WASH.

102 CIRCUIT DIAGRAM

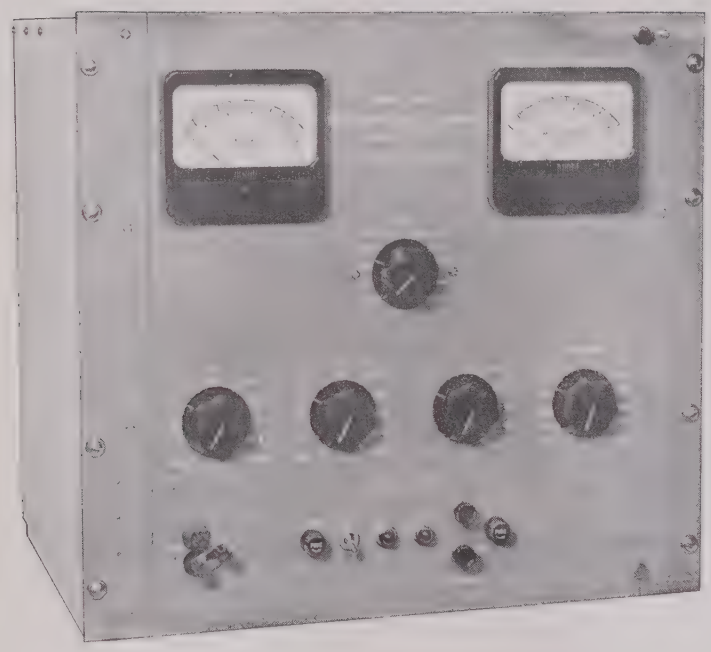
MODEL 02 | DWG NO 102-117

DATE 5/4/48 | DRAWN | CHECKED

FLUKE

TECHNICAL DATA

301C POWER SUPPLY



FEATURES

1.02 to 1012 VDC - 0 to 400 MA

0.005% Regulation

Chopper Stabilized

Standard Cell Reference

500 Microvolt Resolution

0.1% Calibration Accuracy

The Model 301C is a chopper-stabilized, standard cell referenced, calibrated, precision DC power supply which will satisfy the most exacting requirements of laboratory or production line.

With its 400 milliampere, 1 KV output, it is truly a brute force supply. Because of conservative design this supply may be operated indefinitely within specifications for any rated input or output.

Five decade voltage controls afford resolution of ±50 microvolts over the entire operating range, and absolute accuracy is better than ±0.1%. Use of a standard cell reference and chopper stabilization imparts to the 301C output voltage stability of better than ±0.01% long term.

A unique hinged panel affords instant access to the printed circuitry without removing the instrument from its rack. This construction also isolates the standard cell and precision wirewound sampling strings from all heat generating elements. A compact, rugged unit of incomparable performance, the 301C stands alone in its field.

SPECIFICATIONS

INPUT VOLTAGE: 117 volts ±10%, 60 cycles, single phase (220 volt model available on request).

INPUT POWER: 875 watts fully loaded, 190 watts standby.

OUTPUT VOLTAGE: 1.02 to 1012 volts DC.

OUTPUT CURRENT: 0 to 400 milliamperes.

OUTPUT POLARITY: Either terminal may be grounded, or both may be left floating.

OUTPUT CONNECTOR: Insulated binding posts on 3/4" centers.

REGULATION vs. LINE: 0.005% or 1 millivolt for ±10% line voltage change.

REGULATION vs. LOAD: 0.005% or 1 millivolt for 200 milliampere load current change.

STABILITY: ±0.005% per hour after 30 min. warmup, less than ±0.01% per day.

OUTPUT IMPEDANCE: Less than 0.05 ohms DC.

TRANSIENT RESPONSE TIME: Less than 200 microseconds.

REFERENCE ELEMENT: Low hysteresis standard cell.

EQUATING ELEMENT: Low Noise chopper.

RIPPLE: Less than 2 millivolts RMS.

VOLTAGE CALIBRATION:

9 -	100 volt steps
10 -	10 volt steps
10 -	1 volt steps
10 -	0.1 volt steps
1 -	0.11 volt vernier

VOLTAGE RESOLUTION: 50 microvolts at any output voltage via 0.11 volt vernier.

VOLTAGE RESETTABILITY: ±0.01%.

CALIBRATION ACCURACY: ±0.1% or 2 millivolts.

METERS: 4" voltmeter 0-1000 volts. 4" milliammeter 0-500 milliamps.

MOUNTING: Standard relay rack, panel slotted to RMA standards. Supply equipped with removable steel cabinet 17-1/2" x 19" x 15-1/2" deep for bench use.

WEIGHT: 138 lbs. with cabinet.

FINISH: Smooth grey baked enamel, panel machine engraved.

PRICE: $985.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

ADDENDA SHEET FOR 301C TEST INSTRUCTIONS

Section XVI Regulation vs. Line & Load change paragraph to read as follows:

"Assuming 'Noisy When Tapped' test proves OK, proceed to check line and load regulation. With 801 nulled at 498v and line at 117v and load selector switch at 996 switch in load--output must not vary more than 75mv (37.5mv on 801 since 2 to 1 divider is being used). If load regulation is high, refer to troubleshooting file. Next vary line from 130 to 105 volts--output must vary less than 75mv. If line regulation is too high, change V17. It may be necessary to try several 6AU6's. Check line and load reg. at 496, 110 two ways, 40, 4 and 1.02 volts. For poor line reg. at 110v with X100 sw. at 0 and lower voltages change V18 and V19 in this order. Maximum tolerances for each output are on the test record."

On data sheet make changes as follows:

Under Regulation, Line & Load, change tolerances for conditions negative ground, floating ground, and positive ground.

50 mv to 75 mv
25 mv to 38 mv
5.5 mv to 8 mv
2 mv to 3.5 mv
1 mv to 1.5 mv

dmb
4/24/60

MODEL 301C TEST PROCEDURE

I. Visual Inspection

This inspection must be performed before the supply is connected to the power line. First, remove plug from the standard cell socket. Check every single solder connection carefully. Adopt an orderly checking route and follow it each time. Touch each connection with an insulated probe. A casual glance at a soldered connection on a tube socket is a waste of time. One lead buried under two or three others may be completely bare of solder and not be noticed by a casual glance. If any connection looks questionable, resolder. Pay particular attention to the soldering of terminal lugs to the copper foil on the printed circuit board. Solder must be flowed from the eyelet or terminal lug to the foil since the mechanical connection alone is sometimes very poor electrically. Check every single solder connection on the chassis, relays and front panel. Examine all connections to the multi-deck switches on the front panel, checking carefully for unsoldered jumper wires and poorly soldered wirewound resistors. Check the first resistor (between 1.02 and 2V positions) on the X1 switch to be sure that it is a 441.36Ω units, not 450Ω. Check the connections to the terminal strip on the left side sheet. Check every terminal nut or screw for tightness. Be certain brass bolt is used to mount R98-R99 combination using small, permanent magnet, if necessary.

Check fit of panel hinged section. Panel must fit with less than 1/32 - inch gap all around and tops of all three panel sections must be in line within plus or minus 1/32 - inch. Read all engraving on front panel for error, omissions or flaws.

Inspect back of supply for missing tubes and bad solder connections. Check all connections on sockets of 866 tubes and on plate feed strip for 807 tubes. Be sure all plate resistors on both sides of strip are 100Ω. Be sure all dropping resistors on large capacitor bank are 150K and bare jumper wires are not touching a capacitor mounting lug that they shouldn't. Remove plate caps from 866 tubes and drape across tubes away from chassis in preparation for further tests. Remove shorting link from binding posts.

II. Ohmmeter Check

A. Check resistance across C7 - screen supply capacitor. It must be at least 10K.
B. Check resistance across C1 - main filter capacitor. It must be at least 30K.
C. Check both ceramic capacitors inside top of cabinet. Both should read infinity. (With shorting link off and R45 thyrite disconnected).
D. Check resistance across C8 and C11 in the plus 200 and minus 200 volt supplies. Must be at least 500 K.
E. Check resistance between G post and plus and minus posts in turn. Must be at least 500 megohms.

F. Connect ohmmeter across output binding posts and check resistance with all knobs set to zero. Should read 450Ω. Turn vernier control fully clockwise - reading should increase to 500Ω. Turn X. 1 control fully CW - reading should increase in 45Ω steps to 900Ω. Turn X 1 fully CW - reading should increase in 450Ω steps to 5, 400Ω. Turn X10 control full CW - reading should increase in 4. 5 steps to approximately 48K. The shunting effect of the voltmeter will begin to show up here and will cause reading to be about 2 K low - hence 48 K instead of 50K. Finally, turn X100 control CW - here the 1 megohm shunting resistance will really be noticed - merely check to see that the resistance increases at each step and that the resistance with all dials set to maximum measures around 310K.

G. Clip black ohmmeter lead to the black wire in the four wire cable from PCB to X100 switch. Connect the read probe to the green wire of the four wire cable. Set all voltage knobs to zero initially and proceed as follows:

Switch Positions	Resistance
X100 - 1 thru 9, others zero	-0-
X100 - 0 X10-2 thru 10	470K
X100 - 0 X10-1	220K
X10 - 0 X1-5 thru 11	110K
X10 - 0 X1-4	88K
X10 - 0 X1-3	66K
X10 - 0 X1-2	44K
X10— 0 X1-1. 02	22K

H. Connect ohmmeter from green to white lead next. Set X100 switch to zero. Must read zeroΩ. Set X100 switch to 1 thru 9 - meter must read 2. 2 megs.

III. Transformer Tap Check

Connect shorting link to negative output post.
To check plate transformer taps on S1A, connect line cord of the 301C to a 6. 3 volt source and connect a zero to 150VAC voltmeter from the negative binding post to one of the two 866A plate caps. Hold relay Ck1 armature in and note voltmeter reading for each position of the X100 switch - meter should read as follows:

X100 Switch Position	Voltage
0. 1. 2	38V
3. 4	52V
5. 6	67V
7	75V
8	83V
9	90V

The important thing to note is that the voltage increases as the knob is turned clockwise. If any voltages are reversed, it indicates improper connection of the primary taps to the switch either at the switch itself or at the terminal board.

IV. Initial Filament and B plus check

Connect supply to 117 volt line and throw filament switch to "on" position. Observe the two neon bulbs on PCB and be sure they glow within seconds of switching on. Next check that all tubes are lit, including two 5651 tubes and the OA3 tube which should glow bright orange. Listen to be sure chopper is operating as evidenced by a definite hum.

V. Screen Supply

Check 807 screen grid supply with line voltage left at 117 volts. Connect neg. lead to VTVM to pos. output post and read screen voltage on the pos. terminal of the screen capacitor to the left of the PCB. This voltage should read about 340 volts with ripple less than .5 volts.

VI. Positive 200 Volt Supply

With line voltage set at 117 volts check plate voltage of 6AQ5 - should run 400 volts plus or minus 15 volts. Ripple should not exceed 2 volts. Next check regulated output voltage - must not be more than 5 volts above or below 202 volts. Ripple should not exceed 5 millivolts. V17 should be removed from its socket for this reading to eliminate amplified noise from the chopper. Check the line regulation of this supply by varying the line voltage from 105 to 130 volts and noting the E_O difference - should not exceed .4 volts.

VII. Negative 200 Volt Supply

Remove OA3 tube from its socket during this check - replace 6AU6 in its socket. Check the negative 200V supply following same procedure as for positive 200V supply. Plate voltage of 6AQ5 should run 385 volts plus or minus 15 volts. Regulated output, ripple and line regulation are same as for other supply.

VIII. 807 Heater Voltages

Check heater voltage of each of the seven 807 tubes. Using an AC VTVM - measure drop across each of the 807 heaters (pins 1 and 5). Must measure approximately 6.3 volts and all seven must lie within 0.4 volts of each other. If any one tube reads much higher or lower than the other six, replace it and recheck heater voltages.

IX. Remaining Heater Voltages

Check all remaining heater voltages. Read voltage at 6AG7 socket - should read 6.3 volts. Blue and green lead connected to V19 (12AX7) should read 6.3 also. The two sets of terminals at the bottom of PCB marked minus HH and plus HH should also read 6.3 volts. The 5V4 filament should read 4.7 volts. Use caution shen reading this voltage since the voltmeter case will be at approximately 400 volts hot.

X. Element Potentials V17, V18, V19, and V20

Check element potentials in AC and DC amplifiers. Clip black probe to neg. output post. Switch X100 switch fully CCW. Plates (Pin 5) of two 6AU6 tubes (V17 and V18) should run from 55 to 70 volts and screen grids (Pin 6) should run 30 to 40 volts. Control grid (Pin 1) of V17 should measure minus 1.2 volts and grid of V18 should measure minus 1.0 volts (using a VTVM). Voltage at pin 1 of V19 should measure 56 to 106 volts as P3 is rotated from one extreme to the other. After recording range, set Pin 1 to 85 volts. Remove negative probe from negative output post and connect to minus 200 volt bus. Check voltage at pin 5 of V20 - should measure 72 volts plus or minus 2 volts. This concludes check of amplifier DC potentials.

XI. Relay Operation

Be sure standard cell remains unplugged for this test.
First, check relay CK4 on the right hand side of the supply mounted on the standard cell cover. This relay is operated by DC voltage from the positive 200 volt supply. To check its pull-in, hold in on the armature of relay CK2. This is the large antenna type relay on the right side sheet. When the armature is held in, CK4 should pull in and hold until the armature is released. Be sure that the plate caps of the 866 tubes are not on the tubes and are suspended away from any metal chassis parts. Now press the ON button and watch to be sure that both relays CK1 and CK2 on the right side sheet pull in. If a loud buzzing is heard when the line is varied from 100 to 130 volts, make adjustments at this time to the relay blades or spring to eliminate the foregoing buzzing. When all three relays are operating satisfactorily, shut supply down and place plate caps on 866 tubes and plug in standard cell plug. Set up 496 volts on front panel dials and select thyrite varistors.

XII. Thyrite Varistors

Thyrite Varistors are used as R44 and R45. These are non-linear resistors selected for use in this circuit to set the rate at which the output of the supply rises or falls when the high voltage is switched on or dialed higher or lower. These resistors are paired so that the current that they draw at a given voltage (3 volts) is in a ratio of approximately 2 to 1, the feedback resistor (R45) drawing twice the current of the chopper resistor (R44). This current, or inversely, this resistance results in a smooth rise rate of about 100 volts per second.

When the varistors have been selected, solder them in place in a temporary fashion without cutting their leads off. Use caution to conduct heat away from the body of the resistor by holding point nose pliers between soldering iron and resistor body. Feedback resistor (R45) is installed between two lugs above 12AX7 socket (V19) on foil side of PCB. The left lug can be identified by a 27K 1-watt resistor attached to it. The right lug is on the ground foil. Chopper resistor (R44) is installed between the afore-mentioned ground lug and the lug directly below it, identifiable by a 1 mfd at 200 volt polystyrene capacitor connected to it.

After the varistors are installed, temporarily ground the filament lug (pin 9 of V19) to the adjacent ground lug. The supply is now ready for testing of the regulated high voltage output.

XIII. Main Supply Initial Operation

Before pushing the Plate "on" button, double check that the 866 Plate caps are in place on the tubes, the standard cell is plugged in and all tubes that were removed during previous tests are in their proper sockets. Negative output post should be linked to the "G" post. Front panel dials should be set at 496 volts. Connect ripple meter through a blocking capacitor to output posts and push "ON" button being ready to push "OFF" button if front panel meter does not rise steadily at about 100 volts per second to approximately 500 volts and stop.

If voltage rise is too fast or oscillates several times before coming to rest, try another thyrite pair. Ripple meter is good way to observe oscillation if present. If voltage rises too slowly it indicates another pair should be tried, also. Both R44 and R45 affect the rise time. If R44 appears as a very high resistance at a very low voltage, the rise time will be very short. For instance, a resistor which has a resistance of 330K at 2 volts would give a rise time of 400 volts per second. If R45 appears as a very low resistance at a very low voltage, the rise time will also be short. A feedback thyrite of 100K at 3.8 volts would give a rise time of 250 volts per second. Note that the "sense" is opposite for R44 and R45--that is, a high resistance R44 causes fast rise whereas a low resistance R45 causes fast rise also.

If voltage rises at proper rate but continues on above set voltage and loses control, it is reasonable to assume that all circuitry from the input (pin 7 of the 12AX7) on, is operating properly but the reference signal is absent due to malfunction in the sample string, chopper circuit or AC amplifier section. For more detailed trouble-shooting aids, refer to trouble-shooting file. If trouble is not quickly located, a signal tracing procedure should be employed to check the AC amplifier and attenuator. To do this, disconnect the standard cell plug and connect millivolt source from pin 2 of the chopper to the negative bus. Trace signal with scope and AC VTVM into grid of V17 and out of plate. Next follow through attenuator to grid of V18 making measurement on white

wire in 4 wire cable to X100 switch. The scope hookup would load down the grid of V18. The gain of the AC amplifier is 15,000 with the X100 switch in positions 1 through 9. A 1 mv DC voltage at the input to the chopper should produce a 15 v AC signal at the plate of V18. If OK, check action of synchronous rectifier by connecting DC VTVM across C19. The 15 v AC signal should appear as a 15 v DC voltage across C19. If no DC, check R42, R43, R44, C17, and C19.

If voltage rises immediately to the main supply voltage (which, with X100 sw. at 4, would be about 800 v) and fails to regulate, it can be assumed trouble is in 12AX7, 6AG7 or 807 stages. A gassy 807 can cause uncontrolled conduction and should be eliminated by substitution being careful to shut down supply and allow C1 to bleed for 30 seconds before touching plate caps. Use of the millivolt source as described earlier can be extended to trace signal through the 12AX7 and 6AG7 stages. Varying the millivolt signal into the chopper should cause a readable voltage change at pin 6 of the 12AX7. A similar change should be seen at the plate (pin 8) of the 6AG7, but, since this plate voltage is supplied by the 807 screen supply, the high voltage must be on and care must be exercised while making these readings.

Only a general outline of troubles and cures can be given here, but more specific symptoms and possible causes may be found in the 301C trouble-shooting file.

Assuming initial operation satisfactory, proceed with check of offset, regulation, ripple and calibration accuracy.

XIV. Offset

**A word of caution is in order at this point. Due to the rise and fall rate of the 301C power supply output, damage to certain precision wirewound resistors can result from switching the front panel dials too rapidly. A study of the schematic would reveal, for instance, that switching from several hundred volts to minimum output (1.02 v) rapidly would switch all sample resistors across the output out of the circuit except R98, R99, and P2 totaling only 460Ω. Since the output drops slowly, a large current will flow through the resistors, damaging them beyond use. A good rule to follow is:

**NEVER SWITCH THE X100 SWITCH FROM 1 to 0 WITHOUT X10 SWITCH BEING AT LEAST UP TO 6.

Offset refers to the difference in the output of the supply when pin 7 of the 12AX7. is varied from plus .04 volts to minus .04 volts, the operating limits of this stage for best linearity. To check offset, switch supply down to 1.02 volts. Connect VTVM from negative output post to pin 7 of V19 and set plus .04 volts by adjusting P3 - the 10K pot on the PCB. Read output on 801 and record in proper place on test form. Readjust P3 to bring pin 7 V19 through zero to minus .04 volts and record output on test form. Subtract the smaller output voltage from the larger and record this as the offset - should not exceed .004 volts. If it does, try another pair of Thyrites and recheck offset. Before proceeding, set P3 so output of supply is 1.0190 volts.

XV. Ripple

Ripple should first be measured in the negative grounded mode so the link should be fastened from the negative output post to the "G" post. The 301C load should be plugged into the output posts first then the blocking capacitor being certain that the black of common lead is connected to the grounded output post.

Set front panel controls to 996 v and load dial to 996 also. Push "ON" button and note total rise time in seconds and record in space provided in section XII on first page of test record.

Check ripple at no load through the input voltage range of 105 to 130 volts. If ripple is in excess of 1 mv, try reversing AC power to coil of CK2. Next try replacing 6AU6, 6AG7, and 12AX7 in this order. Other possible causes of high eo are defective feedback capacitor C22, leaky C19, leakage heater to grid circuit of 6AG7, incorrect value of capacitor used in corrective network (C21-R53), too large a value will lower the DC amplifier gain at low frequencies. Also recheck Aux. Supplies and Screen Supply for Excessive ripple.

Next switch in load-ammeter should read 400 ma and ripple must stay under 2 mv over the 105 to 130 volt input range. Decrease line voltage with load still on and note at what voltage supply loses control. This must happen at less than 100 volts line. If in excess of this, check the 866 mercury vapor rectifiers visually to see that they both are glowing equally. Excessive drop across one of the 807 plate resistors could cause this. With supply shut down check these resistors with an ohmmeter - should read 100Ω plus or minus 10%. 807 tubes should be checked by substitution and screen supply remeasured to make certain it reads at least 320 volts at 117 volts line. If less than this, replace 5V4.

If excessive ripple shows up under load only, it may be a problem of poor load regulation which, when cured, would result in reduced eo.

In the event difficulties are encountered which are not covered here, refer to 301C Trouble-shooting File under Ripple.

Assuming ripple is less than 2 mv (preferably less than 1 mv) proceed with the second page of the test record. Measure and record ripple at no load and full load at the following voltages: 996, 496, 110, 40, 4, and 1.02.

Remove shorting link and repeat readings at each output being careful that load switch is set at proper voltage each time load is applied. During any tests in this, the floating mode use extreme care not to come into contact with the scope of AC VTVM case since they may assume some elevated potential.

Shut down main supply and connect shorting link from positive output terminal to "G" post. Reverse blocking capacitor connection so that the hot lead is on the ungrounded negative post. Bring supply into operation and record ripple in the same outputs as before.

If supply shows any tendency to oscillate at high load currents, replace C26, C21, and C20 in this order.

XVI. Regulation vs. Line & Load

With supply shut down, disconnect blocking capacitor and load and reconnect shorting link from negative to "G" post. Connect a 2 to 1 divider to output posts observing polarity then reconnect load. Connect 801 to output of divider. Set 301C to 996 v and bring into operation. 801 should null at approximately 498 v. With the 801 in the 10 v null range, adjust P2 (the 5Ω Hundinger pot on the plexiglass board mounted on the back of the output posts) through its full range, making sure its operation is not intermittent--if intermittent or rough, replace and recheck new unit. Tapping this pot lightly with screwdriver handle may reveal an intermittent condition. When satisfied P2 is OK, adjust it so 801 nulls at 498 v on the .1 v null range.

The 301C is a stable instrument and should be able to stand considerable vibration and jarring without affecting the output. It is a must that it pass this test as surely as it passes ripple, regulation and calibration. Using a long insulated probe, methodically tap all components watching for abnormal deflection on the 801. It may help to connect the ripple meter to the output to watch for microphonic tubes. The PCB in the area of V17 is normally somewhat sensitive to tapping due to the high gain in the AC amplifier but a microphonic tube in V17 must never get by this test. V19 and V20 are also troublemakers if they are at all microphonic. Use the probe to flex the PCB in several places. This is a good method of revealing hairline breaks in the foil, rosin or coldsoldered joints or solder blobs almost bridging two separate foil circuits. In a like manner flex the 807 plate resistor strip to check for bad solder joints. Tap all wirewound resistors and flex their leads to test their connection at switch terminal lugs. Tap each switch and relay and flex calbes connecting panel to PCB, also test standard cell wiring. As a final test, slap the sides and top of the cabinet soundly and pound the test bench to see if any of these jarrings cause instability.

Assuming "Noisy When Tapped" test proves OK, proceed to check line and load regulation. When 801 nulled at 498 v and line at 117 v and load selector switch at 996 switch in load-output must not vary more than 75 mv (37.5 mv on 801 since 2 to 1 divider is being used). If load regulation is high, refer to trouble-shooting file. Next vary line from 130 to 105 volts - output must vary less than 75 mv. If line reg. is too hig, change V17. It may be necessary to try several 6AU6's. Check line and load reg. at 496, 110 two ways,

40, 4, and 1.02 volts. For poor line reg. at 110 v with X100 switch at 0 and lower voltages change V18 and V19 in this order. Maximum tolerances for each output are on the test record.

Line and load regulation should next be checked in the floating mode. Cast the shorting link loose and proceed in the same way as before, exercising caution not to touch the metal 801 cabinet when working at the higher outputs.

Finally, regulation is checked in the positive grounded mode. With high voltage off, connect shorting link from pos. to "G" post. Link the 801 input posts in the same manner as the 301 output, being certain that the positive posts on both 301C and 801 are linked to their cases via their "G" posts.

Check line and load regulation at same outputs as other modes.

XVII. Linearity

With high voltage shut down connect shorting link from neg. output post to "G" post. Using 801 and divider box recalibrate supply to 996 closely as possible on the .1 null range. Switch down one position at a time on the X100 switch noting the voltage difference - must not exceed 50 mv per switch step (25 mv thru divider). At 496 the divider can be dispensed with for greater ease in dialing 801. After the X100 switch has been checked, dial the X10 switch and X1 switch to maximum and null 801 on .01 range. Switch down one step at a time on the X10 switch noting difference at null - must not exceed 5 mv per step. Check X1 switch in same manner - difference should not exceed .5 mv per step, however, the lower steps on this switch may exceed this slightly but must never exceed 2 mv. Similarly check the X.1 switch and the .11 v vernier with 2 mv as the maximum tolerance.

XVIII. Meter Accuracy

Set the output to 1,000 volts and check voltmeter reading (be sure meter was carefully zeroed with high voltage off). Should be within 2% or 20 v of 1 kv. Check meter down through all positions of the X100 switch watching for poor linearity. A few meters tend to read slightly low over their entire range. These cases may be corrected by shunting one of the meter divider resistors with a 3.3 megohm 1/2 watt unit. Replace any questionable meters.

To check the ammeter set output to 996 and supply 400 ma load. Meter should read within 2% or 400 ma.

FINAL PRE-CALIBRATION STEPS

Since thyrite resistors were temporarily installed and have since been proven OK, they should now be permanently soldered in place with shortened loads being careful to conduct heat away from disc.

Amplifier filament green and blue leads should now be permanently soldered in place dressing them across PCB neatly cutting excess from lead going to pins 4 and 5. Be sure proper lead gets grounded.

Double check any other solder joints that may have been disturbed in trouble-shooting and clean up any bits of loose solder, insulation, etc.

The supply should now be ready for calibration and stability run.

301C TEST RECORD

Customer P. O. #_____ Serial No._____ Technician_____

1. Visual Inspection
2. Ohmeter Check
3. Plate Transformer Tap Check
4. Initial Filament & B Plus Check
5. Screen Supply
   - Es 807_____v
   - es 807_____v
6. Positive 200 Volt Supply
   - Ek 6AQ5_____v
   - ek 6AQ5_____mv (remove V5 to read)
   - Ek 6AQ5_____mv (line reg. 100-130 v line)
7. Negative 200 Volt Supply
   - Ek 6AQ5_____v
   - ek 6AQ5_____mv (remove OA3 to read)
   - EK 6AQ5_____mv (line reg. 100-130 v line)
8. ef 807
9. ef remaining tubes & chopper
10. Element Potentials V5, V6, V7, V8, (turn X100 sw. fully CCW)

    Ep V17_____V Ep V18_____V
    Es V17_____V Es V18_____V
    Eg V17_____V Eg V18_____V
    (Set at 85 V)
11. Relay Operation
    - CK2 Pull-in
    - CK1 & CK2 pull-in Relays pull-in down to_____v line.
12. Thyrite Varistors
    - Rise time to 1000v_____sec.
    - (Plug in std. cell plug)
13. Main Supply Initial Operation
    - (Note if satisfactory, or, if trouble is encountered, state briefly)
14. Offset
    - Eo at 1.02 w/pin 7 of V7 set at minus .04v = _____v
    - Eo at 1.02 w/pin 7 of V7 set at plus .04v = _____v
    - Difference in Eo at 1.02 (offset)_____v (.004v max.)

301C TEST RECORD

Date:_____ Serial No.:_____ Technician:_____

Output	Regulation: Line	Regulation: Load	Regulation: Tolerance	Ripple: No Load	Ripple: Full Load
		Positive Ground		No Reading Above 2 mv	
1000			75 mv		
110 100 at 0			8.25 mv		
1.02			1.5 mv		
		Floating Ground		No Reading Above 2 mv	
1000			75 mv		
10 100 at 0			8.25 mv		
1.02			1.5 mv		
		Negative Ground		No Reading Above 2 mv	
1000			75 mv		
10 100 at 0			8.25 mv		
1.02			1.5 mv		

Linearity

X100_____ X10_____ X1_____

X.1_____ Vernier_____

Meters

Voltmeter_____ Ammeter_____

Thyrites_____

Calibration & Stability Check with K Pot

Linearity Check - Using Oil Bath Divider

Dial Setting	Deviation in ppm
1000	
900	
800	
700	
600	
500	
400	
300	
200	
100	
50	
10	
5	
1.02	

Check Stability at Max. Eo in Pos. Pol, No Load, 120V Line

Time	K-Pot	Polarity

301C TROUBLE SHOOTING

S=Symptom
C=Possible Cure

HIGH VOLTAGE LOAD REGULATION

S. Very poor load regulation at all outputs and possibly after a time won't reach set voltage.
C. Replace 6AG7.

S. Poor load regulation at all outputs.
C. Make sure that sample connection at output posts make a good point source contact so that there is no IR drop between feed to binding post and reference sample takeoff.

S. Very poor load regulation, combined with door shift. (output voltage shifts as door is swung 45°).
C. Make certain bolt that mounts R98 (457.3Ω) is not a steel bolt. This bolt should be brass.

S. Load regulation slightly out of tolerance.
C. Try reversing phase of chopper coil. Line regulation may change slightly.

S. Output drops drastically under load.
C. Look for defective 866 mercury vapor rectifier or improper value 807 plate resistors. High resistance path in main supply to plates of 807 tubes.

S. Load regulation slightly out of tolerance at 110 V (X100 SW at 0) and 40 v.
C. Replace R-33 (470K) with a 680K unit and recheck.

S. Poor load regulation at all outputs. Poor line regulation and Hi eo also.
C. Reverse phase of CK2 coil.

S. Slightly out of tolerance. Load regulation from 40 v on down.
C. Resistance of binding posts. Try reading Eo from back of posts.

301C TROUBLE SHOOTING

S-Symptom
C-Possible Cure

HIGH VOLTAGE LINE REGULATION

S. Poor line regulation at outputs above 110 volts (with X100 switch in position #1).
C. Replace V17 (6AU6). It may be necessary to try several. Check ripple with new tube.

S. Poor line regulation at outputs of 110 volts and below. (With X100 switch in zero position.)
C. Replace V19 (12AX7) and V18 (6AU6). It may be necessary to try several. Double check ripple with new tube.

S. Poor line regulation at 1.02 (5 mv) and high eo (2 m).
C. Amplifier filaments not grounded.

S. Impossible to get line regulation within tolerance after trying several tubes.
C. Reverse blue and green Amp. filament leads and select ground for lowest ripple.

S. Line regulation slightly out of tolerance at 110 volts (X100 switch at 0) and 40 v.
C. Replace R-33 (470K) with 680K unit and recheck.

S. Poor line regulation at all outputs. Poor load regulation and Hi eo also.
C. Reverse phase of CK2 coil.

301C TROUBLE SHOOTING

S-Symptom
C-Possible Cure

AUXILIARY SUPPLIES

S. High ripple or poor line regulation.
C. Virtually always changing 6AU8 will cure these troubles. It may be necessary to try several tubes.

S. Jitter in +Aux. in standby, making ripple reading difficult.
C. Switch X100 SW. to position #0, or remove V17 and read.

S. Jitter in -Aux. in standby, making ripple reading difficult.
C. Switch X100 SW. to position #0 and make reading. (Ignore Osc.) or, remove OA3 and read.

S. High eo in Neg. Aux. while Pos. Aux, is within tolerance.
C. Switch 6AU8 tubes and both Aux. supplies will come within tolerance in some cases.

S. Neg. 200 hard to read due to jitter and eo too high.
C. Remove OA3 to read ripple and ignore Osc. --disappears W/HV on.

301C TROUBLE SHOOTING

S=Sympton
C=Possible Cure

HIGH VOLTAGE RIPPLE

S. High eo at all outputs.
C. Try grounding opposite Amp. Fil. lead. Also try by substitution C22, C19, C21 - also 6AG7.

S. High eo above 110 (W X100 at 1).
C. Try new 6AU6, V17, or V18.

S. High eo below 110 (W X100 at 0).
C. Try new 12AX7 (V19). Also be sure 1.02 v output is not to far off CAL.

S. High eo at all outputs. Also poor line and load regulation.
C. Reverse phase or CK2 coil.

301C TROUBLE SHOOTING

S=Symptom
C=Possible Cure

HIGH VOLTAGE RISE

S. Eo barely rises at all. Very slow and jerky.
C. Look for intermittent ground or open in chopper circuit.

S. Slow and decreasing rise - almost stops before reaching set voltage.
C. Open screen capacitor V17.

S. Immediate rise to main supply voltage. Does not regulate. Rises and falls with change in line voltage.
C. Open or disconnected filter capacitor C4. Defective (gassy) 807 tube or bad solder connection, especially on grid pin of 807 socket. 6AG7 tube defective or oriented wrong.

S. Normal rise, however does not stop at set voltage, but continues to rise to main supply voltage, and fails to regulate.
C. Since rise rate is proper, the trouble lies ahead of the 12AX7. Things to check are:
Standard cell, chopper and AC amplifier and attenuator circuitry.
(In some cases lack of reference can result in extremely slow rise rate.)

S. Supply produces a negative voltage.
C. Shorted 12AX7 or defect in standard cell circuit.

S. Supply rises slightly fast to set voltage then continues at normal rate to main supply voltage. Won't regulate.
C. Faulty 12AX7.

S. Rise rate too fast (more than 125 V/P/S) or too slow (less than 75)
C. Try new pair of Thyrites (R44 and R45)

S. Rise rate too fast or too slow (normal is 100 v per second).
C. Thyrite varisotrs are not in proper 2 to 1 ratio. (R45 feedback Thyrite should have half the res. of R44 chopper Thyrite).

HIGH VOLTAGE RISE - CONTINUED

S. Voltage rises at normal rate, but over-shoots set voltage and oscillates before settling down.
C. 10 to 15 volt over-shoot is normal--Thyrites or in some cases V17.

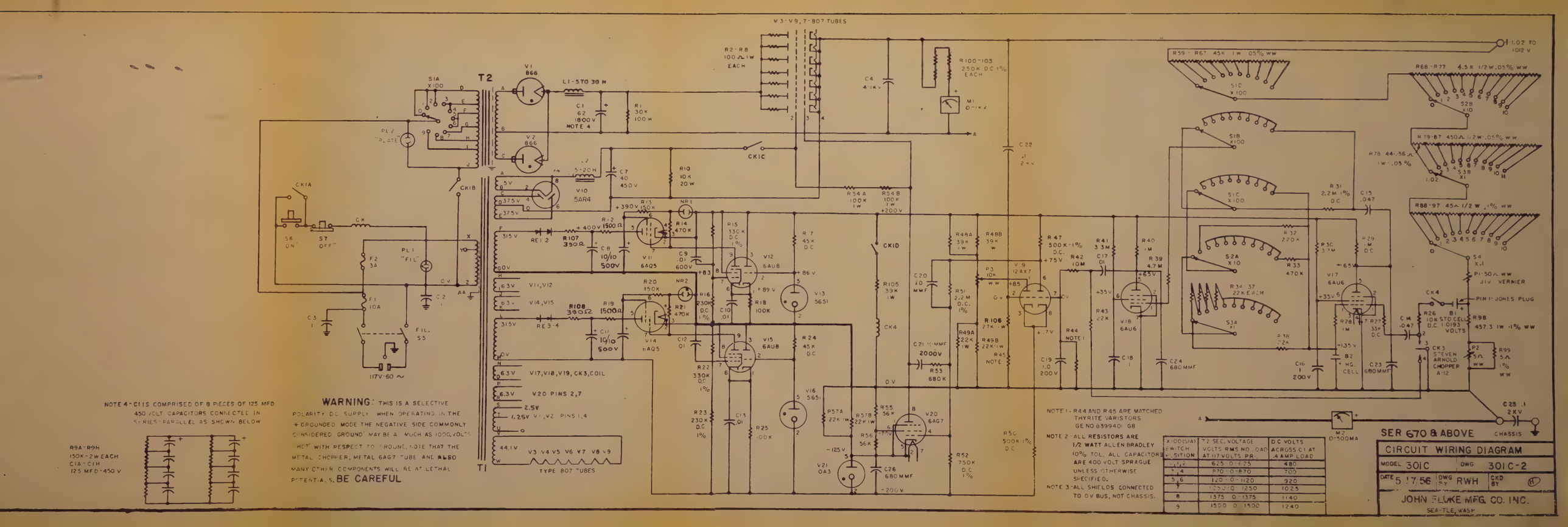
S. Failure to rise at all.
C. Can be caused by no reference. Also DC amplifier.

301C CHANGE SCHEDULE

CHANGE NUMBER	DATE	DESCRIPTION	STARTING SERIAL NO.
1.	5/17/56	Redrawn	124
2.	9/6/56	Changed value of C1	125
3.	12/20/56	Added X.1 switch and resistor Revised control circuit - added CK2 Changed P1 Changed to floating output Added C25, 26, 27, 28, R104, 105, RE7 Delete R25, C3, R46, R52	125
4.	1/30/57	Modified control circuit	126
		Added 39K in series with R44 thyrite	129
		Changed R47 - changed C16 & C19 to 1 @ 200 metalized	130
6.		Added CK4 screen supply relay	133
7.	5/13/57	New panel design - possibly means new meters Started using 2 line capacitors Changed coil wiring CK4 Changed R30 & R41 from 2.2m to 3.3m Changed R38 from 50K to 22K	136
		First Paeco transformers	137
8.	5/29/57	Changed R47, R50 from 10% to L	141
		Changed R44 from 15K, 1 W Changed control wiring from sequential relay Dropout	
		Changed R49 to 11K	142
		Advance relays - this one only	169
9.	7/1/57	Corrected values C8, 11, 14, 15, R39 added C3 Changed presentation of C1, R54, 47, 48, 49 for clarity added circuit symbols PL1, PL2, RE7, NR1, NR2	
		Put 0.11V vernier on standoffs	173
10.	10/26/57	Changed R13 & R20 from 100K to 150K	182
11.	12/17/57	R9 A thru P subsituted by 8 150K @ 1W	190
12.	12/26/57	Changed from DC to AC relays Delete screen relay & use 1/2 of std. cell relay for screen. Delete 250 mfd @ 50V & silicon diode	197

301C CHANGE SCHEDULE (CONTINUED)

CHANGE NUMBER	DATE	DESCRIPTION	STARTING SERIAL NO.
13.	3/13/58	Removed decimal points to left of number on X.1 dial.	211
		Added electrostatic shield to aux. & plate xfmr.	
		Relocated CK2 antenna relay beside std. cell	208
		New mounting method for Ward-Leonard resistor	
14.	4/17/58	Added CK4 Sigma relay to close std. cell ckt.	207
15.	7/21/58	Reversed P3 (10K pot on PCB) for easy access from front side of supply.	
		Changed R2 thru R8 from 1W to 2W size	247
		Relocate twisted leads from PCB to front panel. Now they follow cabinet edge instead of stretching across air gap.	232-235
16.	10/9/58	Added 56 ohm RE5 in screen supply ahead of capacitor	About 282
		Plate xfmr, screen supply, standard cell relay and holding contacts all on one relay mounted on bottom pan inside door.	
		56 ohm resistor mentioned above has been missing since 2/1/59	



X100(S1A) SWITCH POSITION	72 SEC. VOLTAGE VOLTS RMS NO. OAD AT 117 VOLTS PRI.	DC VOLTS ACROSS C1 AT .4 AMP LOAD
1,2	625 - 0 - 625	480
3,4	870 - 0 - 870	700
5,6	1120 - 0 - 1120	920
7	1250 - 0 - 1250	1025
8	1375 - 0 - 1375	1140
9	1500 - 0 - 1500	1240

FLUKE

TECHNICAL DATA

301E POWER SUPPLY

FEATURES

1.02 to 512 VDC - 0 to 300 MA

0.005% Regulation

Chopper Stabilized

Standard Cell Reference

500 Microvolt Resolution

0.1% Calibration Accuracy

The Model 301E is a chopper stabilized, standard cell referenced, calibrated precision DC power supply which will satisfy the most exacting requirements of laboratory or production line.

With its 300 milliampere, 512 volt output, it is truly a versatile supply. Because of extremely conservative design, this supply may be operated indefinitely within specifications for any input or output.

Five decade voltage controls afford resolution of ±0.5 millivolt over the entire operating range, and absolute accuracy is better than ±0.1%. Use of a standard cell reference and chopper stabilization imparts to the 301E output voltage stability of better than ±0.01% long term.

Unique barrier construction isolates the standard cell and precision wirewound sampling strings from all heat generating elements. A compact, rugged unit of incomparable performance, the 301E stands alone in its field.

SPECIFICATIONS

INPUT VOLTAGE: 117/220/234 volts ±10%, 50-60 cycles, single phase.

INPUT POWER: 350 watts fully loaded. 110 watts standby.

OUTPUT VOLTAGE: 1.02 to 512 volts DC.

OUTPUT CURRENT: 0 to 300 milliamperes.

OUTPUT POLARITY: Either terminal may be grounded, or both may be left floating.

OUTPUT CONNECTOR: Insulated binding posts on 3/4" centers. Terminal strip on rear.

REGULATION vs LINE: 0.005% or 1 millivolt for ±10% voltage change.

REGULATION vs LOAD: 0.005% or 1 millivolt for 150 milliampere load current change.

STABILITY: 0.005% per hour after 30 min. warmup, less than 0.01% per day.

OUTPUT IMPEDANCE: Less than 0.1 ohm DC, 1 ohm at 100 KC.

TRANSIENT RESPONSE: 0.2 millisecond for full load, or ±10% line change.

REFERENCE ELEMENT: Low hysteresis standard cell.

EQUATING ELEMENT: Low noise chopper.

RIPPLE: Less than 2 millivolts RMS.

VOLTAGE CALIBRATION:

4 -	100	volt steps
10 -	10	volt steps
10 -	1	volt steps
10 -	0.1	volt steps
1 -	0.11	volt steps

VOLTAGE RESOLUTION: 50 microvolts at any output via 0.11 volt vernier.

VOLTAGE RESETTABILITY: 0.01%.

CALIBRATION ACCURACY: Better than 0.1% or 2 millivolts.

METER: 4-1/2" with switch for selectively reading output voltage and current.

DIMENSIONS: Panel 8-3/4" high, 19" wide. Depth 18".

MOUNTING: Standard relay rack, panel slotted to RMA standards. Supply equipped with removable resilient feet for bench use.

SHIPPING WEIGHT: 54 lbs.

FINISH: Aluminum. Panel gray high glass baked enamel, machine engraved.

PRICE: $695.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

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MODEL 301E TEST PROCEDURE

I. Visual Inspection

This inspection must be performed before the supply is connected to the power line. First, remove plug from the standard cell socket. Check every single solder connection carefully. Adopt an orderly checking route and follow it each time. Touch each connection with an insulated probe. A casual glance at a soldered connection on a tube socket is a waste of time. One lead buried under two or three others may be completely bare of solder and not be noticed by a casual glance. If any connection looks questionable, resolder. Pay particular attention to the soldering of terminal lugs to the copper foil on the printed circuit boards. Solder must be flowed from the eyelet or terminal lug to the foil since the mechanical connection alone is sometimes very poor electrically. Check every single solder connection on the chassis, relays and front panel. Examine all connections to the multi-deck switches on the front panel, checking carefully for unsoldered jumper wires and poorly soldered wirewound resistors. Check the first resistor (between 1.02 and 2V positions) on the X1 switch to be sure that it is a 441.36 ohm unit, not 450 ohm. Check the connections to the terminal strip on the back sheet. Be sure jumper is installed between two end terminals marked "SW". Check polarity of 12 diodes on power PCB comparing markings on diodes with markings on PCB. Be certain brass bolt is used to mount R98-R99 combination using small, permanent magnet, if necessary.

Read all engraving on front panel for error, omissions or flaws. Check the engraved dial plates for centering of numerals in panel window. The zero numeral on the X.22 Pot. dial should be centered in the window when the pot wiper just starts onto the winding.

Inspect top of supply for missing tubes and bad solder connections. Check all connections on plate feed stand-offs for 807 tubes. Be sure all plate resistors on both strips are 100 ohm. Check 3 groups of selenium rectifiers for polarity.

II. Ohmeter Check

A. Check resistance across C7 - screen supply capacitor. It must be at least 150K. The resistance across C3 and C4 should be 70K ea. with all knobs max. cw.

B. Check resistance across C1 and C2 - main filter capacitors. They must be at least 10K each.

C. Check parallel 0.047 mfd capacitors (bottom left side). Pair should read infinity. (With shorting link off and R45 thyrite disconnected).

D. Check resistance across C8 and C11 in the plus 200 and minus 200 volt supplies. Must be at least 500K.

E. Check resistance between G post and plus and minus posts in turn. Must be at least 500 megohms.

F. Connect ohmeter across output binding posts and check resistance with all knobs set to zero. Should read 450 ohm. Turn vernier control fully clockwise - reading should increase to 500 ohms. Turn X 0.1 control fully CW - reading should increase in 45 ohm steps to 900 ohms. Turn X 1 fully CW - reading should increase in 450 ohm steps to 5,400 ohm. Turn X10 control

full CW - reading should increase in 4.5 steps to approximately 48K. The voltmeter will begin to show up here and will cause reading to be about 2K low - hence 48K instead of 50K. Finally, turn X100 control CW - here the 1 megohm shunting resistance will really be noticed - merely check to see that the resistance increases at each step and that the resistance with all dials set to maximum measures around 90K.

G. Clip black ohmeter lead to the black wire in the four wire cable from PCB to X100 switch. Connect the red probe to the green wire on the four wire cable. Set all voltage knobs to zero initially and proceed as follows:

Switch Positions	Resistance
X100 - 1 thru 4, others zero	-0-
X100 - 0 X10-2 thru 10	470K
X100 - 0 X10-1	220K
X10 - 0 X1-5 thru 11	110K
X10 - 0 X1-4	88K
X10 - 0 X1-3	66K
X10 - 0 X1-2	44K
X10 - 0 X1-1.02	22K

H. Connect ohmeter from green to white lead next. Set X100 switch to zero. Must read zero ohm. Set X100 switch to 1 thru 4 - meter must read 2.2 megs.

III. Initial Filament and B Plus Check

Connect supply to 117 volt line and throw power switch to "on" position. Observe the two neon bulbs on PCB and be sure they glow within seconds of switching on. Next check that all tubes are lit, including two 5651 tubes and the 0A3 tube which should glow bright orange. Listen to be sure chopper is operating as evidenced by a definite hum.

IV. Transformer Secondary Tap & Diode Check

With VTVM set on 1500v DC range, connect black common meter lead to the negative side (shell) of capacitor C2 on the power PCB. With the DC probe read the voltage on the positive side of capacitor C1 (junction of 10 ohm, 5 watt resistor and C1 center terminal). The following voltages should be present at indicated settings of X100 switch @ 130 volts a/c input:

X100 sw. @ 0	300v	
X100 sw. @ 1	420v	
X100 sw. @ 2	550v	(all rdgs. ±10%)
X100 sw. @ 3	700v	
X100 sw. @ 4	840v	

Using blocking capacitor and AC VTVM read ripple across these same capacitors. With X100 sw. @ 4, line 130v, the AC component should not exceed 2.5v.

V. Screen Supply

Check 807 screen grid supply with line voltage left at 117 volts. Connect neg. lead of VTVM to pos. output post and read screen voltage on the pos. terminal of the screen capacitor - C7 - on the power PCB. This voltage should read about 340 volts with ripple less than 0.5 volts.

VI. Positive 200 Volt Supply

With line voltage set at 117 volts check plate voltage of 6AQ5 - should run 400 volts plus or minus 15 volts. Ripple should not exceed 2 volts. Next check regulated output voltage - must not be more than 5 volts above or below 202 volts. Ripple should not exceed 5 millivolts. V5 should be removed from its socket for this reading to eliminate amplified noise from the chopper. Check the line regulation of this supply by varying the line voltage from 105 to 130 volts and noting the Eo difference - should not exceed 0.4 volts.

VII. Negative 200 Volt Supply

Remove 0A3 tube from its socket during this check - replace 6AU6 in its socket. Check the negative 200V supply following same procedure as for positive 200 V supply. Plate voltage of 6AQ5 should run 385 volts plus or minus 15 volts. Regulated output, ripple and line regulation are same as for other supply.

VIII. 807 Heater Voltages

Check heater voltage of each of the four 807 tubes. Using an AC VTVM - measure drop across each of the 807 heaters (pins 1 and 5). Must measure approximately 6.3 volts and all four must lie within 0.4 volts of each other. If any one tube reads much higher or lower than the other three, replace it and recheck heater voltages.

IX. Remaining Heater Voltages

Check all remaining heater voltages. Read voltage at 6AG7 socket - should read 6.3 volts. Blue and green lead connected to V7 (12AX7) should read 6.3 also. The two sets of terminals at the bottom of PCB marked minus HH and plus HH should also read 6.3 volts. A visual check should be made for operation of 2 meter lamps and decimal light.

X. Element potentials V5, V6, V7 & V8

Check element potentials in AC and DC amplifiers. Clip black probe to neg. output post. Switch X100 switch fully CCW. Plates (Pin 5) of the two 6AU6 tubes (V5 and V6) should run from 55 to 70 volts and screen grids (Pin 6) should run 30 to 40 volts. Control grid (Pin 1) of V5 should measure minus 1.2 volts and grid of V6 should measure minus 1.0 volts (using a VTVM). Voltage at pin 1 of V7 should measure 50 to 100 volts as P3 is rotated from one extreme to the other. After recording range, set Pin 1 to 85 volts. Remove negative probe from negative output post and connect to minus 200 volt bus. Check voltage at Pin 5 of V8 - should measure 72 volts plus or minus 2 volts. This concludes check of amplifier DC potentials.

XI. Relay Operation

Be sure standard cell remains unplugged for this test.
First check relay CK2 on the bottom left hand side of the supply mounted on the side sheet. This relay is operated by DC voltage from the positive 200 volt supply. To check its pull-in, hold in on the large blade of relay CK1 nearest the amp. PCB. When this blade is held in, CK2 should pull in and hold until the armature is released. Now rotate the operate switch to "start" and watch to be sure that both relays CK1 and CK2 pull in. If a loud buzzing is heard when the line is varied from 100 to 130 volts, make adjustments at this time to the relay blades or spring to eliminate the foregoing buzzing. When both relays are operating satisfactorily, shut supply down and plug in standard cell plug. Set up 499 volts on front panel dials and select thyrite varistors.

XII. Thyrite Varistors

Thyrite Varistors are used as R44 and R45. These are non-linear resistors selected for use in this circuit to set the rate at which the output of the supply rises or falls when the high voltage is switched on or dialed higher or lower. These resistors are paired so that the current that they draw at a given voltage (3 volts) is in a ratio of approximately 2 to 1, the feedback resistor (R45) drawing twice the current of the chopper resistor (R44). This current, or inversely, this resistance results in a smooth rise rate of about 100 volts per second. When the varistors have been selected, solder them in place in a temporary fashion without cutting their leads off. Use caution to conduct heat away from the body of the resistor by holding point nose pliers between soldering iron and resistor body. Feedback resistor (R45) is installed between two lugs above 12AX7 socket (V7) on foil side of PCB. The left lug can be identified by a 27K 1-watt resistor attached to it. The right lug is on the ground foil. Chopper resistor (R44) is installed between the afore-mentioned ground lug and the lug directly below it, identifiable by a 1 MFD at 200 volt polystyrene capacitor connected to it. These directions are written assuming the board is being viewed so that all letters or numbers printed on board are horizontal.

After the varistors are installed, the supply is ready for testing of the regulated high voltage output.

XIII. Main Supply Initial Operation

Before rotating the operate switch to "start", double check that the 807 plate caps are in place on the tubes, the standard cell is plugged in and all tubes that were removed during previous tests are in their proper sockets. Negative output post should be linked to the "G" post. Front panel dials should be set at 499 volts. Connect ripple meter through a blocking capacitor to output posts and rotate switch to "start" being ready to return to "standby" if front panel meter does not rise steadily at about 100 volts per second to approximately 500 volts and stop.

If voltage rise is too fast or oscillates several times before coming to rest, try another thyrite pair. Ripple meter is good way to observe oscillation if present. If voltage rises too slowly it indicates another pair should be tried, also. Both R44 and R45 affect the rise time. If R44 appears as a very high resistance at a very low voltage, the rise time will be very short. For instance, a resistor which has a resistance of 330 K at 2 volts would give a rise time of 400 volts per sec. If R45 appears as a very low resistance at a very low voltage, the rise time will also be short. A feedback thyrite of 100K at 3.8 volts would give a rise time of 250 volts per sec. Note that the "sense" is opposite for R44 and R45 -- that is, a high resistance R44 causes fast rise whereas a low resistance R45 causes fast rise also.

If voltage rises at proper rate but continues on above set voltage and loses control, it is reasonable to assume that all circuitry from the input (pin 7 of the 12AX7) on, is operating properly but the reference signal is absent due to malfunction in the sample string, chopper circuit or AC amplifier section. For more detailed trouble-shooting aids, refer to trouble-shooting file. If trouble is not quickly located, a signal tracing procedure should be employed to check the AC amplifier and attenuator. To do this, disconnect the standard cell plug and connect millivolt source from pin 2 of the chopper to the negative bus, Trace signal with scope and AC VTVM into grid of V5 and out of plate. Next follow through attenuator to grid of V6 making measurement on white wire in 4 wire cable to X100 switch. The scope hookup would load down the grid of V6. The gain of the AC amplifier is 25,000 with the X100 switch in positions 1 through 4. A 1 mv DC

voltage at the input to the chopper should produce at 25 v AC signal at the plate of V6. If OK, check action of synchronous rectifier by connecting DC VTVM across C19. The 25 v AC signal should appear as a 25 v DC voltage across C19. If no DC, check R42, R43, R44, C17 and C19.

If voltage rises immediately to the main supply voltage (which, with X100 sw. @4, would be about 700 V.) and fails to regulate, it can be assumed trouble is in 12AX7, 6AG7 or 807 stages. A gassy 807 can cause uncontrolled conduction and should be eliminated by substitution being careful to shut down supply and allow C1 to bleed for 30 seconds before touching plate caps. Use of the millivolt source as described earlier can be extended to trace signal through the 12AX7 and 6AG7 stages. Varying the millivolt signal into the chopper should cause a readable voltage change at pin 6 of the 12AX7. A similar change should be seen at the plate (Pin 8) of the 6AG7, but, since this plate voltage is supplied by the 807 screen supply, the high voltage must be on and care must be exercised while making these readings.

Only a general outline of troubles and cures can be given here, but more specific symptoms and possible causes may be found in the 301E trouble-shooting file.

OSC @ various Eo on various instruments - install 0.002 - 1600v bypass at binding posts on rear deck of panel.

Assuming initial operation satisfactory, proceed with check of offset, regulation, ripple and calibration accuracy.

XIV. Offset

**A word of caution is in order at this point. Due to the rise and fall rate of the 301E power supply output, damage to certain precision wirewound resistors can result from switching the front panel dials too rapidly. A study of the schematic would reveal, for instance, that switching from several hundred volts to minimum output (1.02v) rapidly would switch all sample resistors across the output out of the circuit except R98, R99 and P2 totaling only 460 ohm. Since the output drops slowly, a large current will flow through the resistors, damaging them beyond use. A good rule to follow is:

**NEVER SWITCH THE X100 SWITCH FROM 1 TO 0 WITHOUT X10 SWITCH BEING AT LEAST UP TO 6.

Offset refers to the difference in the output of the supply when Pin 7 of the 12AX7 is varied from plus 0.04 volts to minus 0.04 volts, the operating limits of this stage for best linearity. To check offset, switch supply down to 1.02 volts. Connect VTVM from negative output post to Pin 7 of V7 and set plus 0.04 volts by adjusting P3 - the 10K pot on the PCB. Read output on 801 and record in proper place on test form. Readjust P3 to bring Pin 7 V7 through zero to -0.04 volts and record output on test form. Subtract the smaller output voltage from the larger and record this as the offset - should not exceed 0.004 volts. If it does, try another pair of thyrites and recheck offset. Before proceeding, set P3 so output of supply is 1.0190 volts.

XV. Ripple

Ripple should first be measured in the negative grounded mode so the link should be fastened from the negative output post to the "G" post. The 301E load should be plugged into the output posts first then the blocking capacitor being certain that the black or common lead is connected to the grounded output post.

Set front panel controls to 457v and load plug to 457 also. Rotate sw to "start" and note total rise time in seconds and record in space provided in section XII on first page of test record.

Check ripple at no load through the input voltage range of 105 to 130 volts. If ripple is in excess of 2mv, try replacing 6AU6, 6AG7 and 12AX7 in this order. Other possible causes of high eo are defective feedback capacitor C22, leaky C19, leakage heater to grid circuit of 6AG7, incorrect value of capacitor used in corrective network (C21-R53), too large a value will lower the DC amplifier gain at low frequencies. Also recheck Aux. Supplies and Screen Supply for excessive ripple.

Next switch in load. Ripple must stay under 2mv over the 105 to 130 volt input range. Decrease line voltage with load still on and note at what voltage supply loses control. This must happen at less than 100 volts line. Excessive drop across one of the 807 plate resistors could cause high line min. With supply shut down check these resistors with an ohmeter - should read 100 ohm plus or minus 10%. 807 tubes should be checked by substitution and screen supply re-measured to make certain it reads at least 320 volts at 117 volts line. Faulty diodes in bridge circuit could cause this also.

If excessive ripple shows up under load only, it may be a problem of poor load regulation which, when cured, would result in reduced eo.

In the event difficulties are encountered which are not covered here, refer to 301E Troubleshooting File under Ripple.

Assuming ripple is less than 2 mv (preferably less than 1mv) proceed with the second page of the test record. Measure and record ripple at no load and full load at the following voltages: 457, 110, 45, 3 and 1.02.

Remove shorting link and repeat readings at each output being careful that load switch is set at proper voltage each time load is applied. During any tests in this, the floating mode use care not to come into contact with the scope of AC VTVM case since they may assume some elevated potential.

Shut down main supply and connect shorting link from positive output terminal to "G" post. Reverse blocking capacitor connection so that the hot lead is on the ungrounded negative post. Bring supply into operation and record ripple in the same outputs as before.

If supply shows any tendency to oscillate at high load currents, replace C26, C21 and C20 in this order.

XVI. Regulation vs. Line & Load

With supply shut down, disconnect blocking capacitor and load and reconnect shorting link from negative to "G" post. Connect 801 to output of supply. Set 301E to 457 and bring into operation. 801 should null at approximately 457v. With the 801 in the 10v null range, adjust P2 (the 5 ohm Hundinger pot on the plexiglass board mounted on the back of the vernier pot) through its full range, making sure its operation is not intermittent - if intermittent or rough, replace and recheck new unit. Tapping this pot lightly with screwdriver handle may reveal an intermittent condition. When satisfied P2 is OK, adjust it so 801 nulls at 457 on the 0.1 v null range.

The 301E is a stable instrument and should be able to stand considerable vibration and jarring without affecting the output. It is a must that it pass this test as surely as it passes ripple, regulation and calibration. Using a long insulated probe, methodically tap all components watching for abnormal deflections on the 801. It may help to connect the ripple meter to the output to watch for microphonic tubes. The PCB in the area of V5 is normally somewhat sensitive to tapping due to the high gain in the AC Amplifier but a microphonic tube in V5 must never get by this test. V7 and V8 are also troublemakers if they are at all microphonic. Use the probe to flex the PCB in several places. This is a good method of revealing hairline brakes in the foil, rosin or cold-soldered joints or solder blobs almost bridging two separate foil circuits. Tap all wire-sound resistors and flex their leads to test their connection at switch terminal lugs. Tap each switch and relay and flex cables connecting panel to PCB, also test std. cell wiring. As a final test, slap the sides of the cabinet soundly and pound the test bench to see if any of these jarrings cause instability.

Assuming "Noisy When Tapped" test proves OK, proceed to check line and load regulation. With 801 nulled at 457 and line at 117v and load box plug at 457 switch in load-output must not vary more than 22mv. If load regulation is high, refer to troubleshooting file. Next vary line from 130 to 105 volts - output must vary less than 22mv. If line reg. is too high, change V5. It may be necessary to try several 6AU6's. Check line and load reg. at 457, 110 two ways, 45, 3 and 1.02 volts. For poor line reg. at 110v with X100 sw. at 0 and lower voltages change V6 and V7 in this order. Maximum tolerances for each output are on the test record.

Line and load regulation should next be checked in the floating mode. Cast the shorting link loose and proceed in the same way as before, exercising caution not to touch the metal 801 cabinet when working at the higher outputs.

Finally, regulation is checked in the positive grounded mode. With high voltage off, connect shorting link from pos. to "G" post. Link the 801 input posts in the same manner as the 301 output, being certain that the positive posts on both 301E and 801 are linked to their cases via their "G" posts.

Check line and load regulation at same outputs as other modes.

XVII. Linearity

With high voltage shut down connect shorting link from neg. output post to "G" post. Using 801 recalibrate supply to 500v closely as possible on the 0.1 null range. Switch down one position at a time on the X100 sw. noting the voltage difference must not exceed 50mv per switch step. After the X100 sw. has been checked, dial the X10 sw. and X1 sw. to maximum and null 801 on 0.01 range. Switch down one step at a time on the X10 sw. noting difference at null - must not exceed 5mv per step, however, the lower steps on this switch may exceed this slightly but must never exceed 2 mv. Similarly check the X.1 sw. and the 0.11v vernier with 2mv as the maximum tolerance.

XVIII. Meter Accuracy

Set the output to 500 volts and check voltmeter reading (be sure meter was carefully zeroed with high voltage off). Should be within 2% or 10v or 500v. Check meter down through all positions of the X100 sw. watching for poor linearity. Replace any questionable meters or meter divider resistors.

To set the ammeter shunts, apply 300ma load and monitor current with standard milliameter. Adjust meter shunt so panel meter reads within 2% of 300ma and 150ma.

FINAL PRE-CALIBRATION STEPS

Since thyrite resistors were temporarily installed and have since been proven OK, they should now be permanently soldered in place with shortened leads being careful to conduct heat away from disc.

Double check any other solder joints that may have been distrubed in troubleshooting and clean up any bits of loose solder, insulation, etc.

The supply should now be ready for calibration and stability run.

ADDENDA SHEET FOR 301E TEST INSTRUCTIONS

Section XVI Regulation vs. Line & Load Change paragraph to read as follows:

"Assuming 'Noisy When Tapped' Test proves OK proceed to check line and load regulation. With 801 nulled at 457 and line at 117v and load box plug at 457 switch in load--output must not vary more than 33mv. If load regulation is high, refer to troubleshooting file. Next vary line from 130 to 105 volts--output must vary less than 33mv. If line reg. is too high, change V5. It may be necessary to try several 6AU6's. Check line and load reg. at 457, 110 two ways. 45, 3, and 1.02 volts. For poor line reg. at 110v with X100 sw. at 0 and lower voltages change V6 and V7 in this order. Maximum tolerances for output are on the test record.

On data sheet under Regulation, line and load negative ground, floating ground, and positive ground change the following tolerances:

22 mv	to	33 mv
5.5 mv	to	8mv
2.2 mv	to	3.3 mv
1 mv	to	1.5 mv

dmb
4/25/60

301E TROUBLESHOOTING

See. 301C Troubleshooting section. All 301C symptoms are common to the 301E

301E CHANGE SCHEDULE

CHANGE NUMBER	DATE	DESCRIPTION	STARTING SERIAL NO.
1.	12/58	Changed value of R53 from 680K to 470K	124
2.	12/58	Added 0.002 1600V capacitor across output terminals	133 only
3.	12/58	Added extra support to power PCB #124 & 129.	

301E TEST RECORD

Date:_____

Customer P.O.#_____ Serial No._____ Technician_____

1. Visual Inspection
2. Ohmeter Check
3. Initial Filament & B Plus Check
4. Transformer secondary tap and diode check
5. Screen supply
   - Es 807_____V
   - es 807_____V
6. Positive 200 Volt Supply
   - Ek 6AQ5_____v
   - ek 6AQ5_____mv (remove V5 to read)
   - EK 6AQ5_____mv (line reg. 100-130 v line)
7. Negative 200 Volt Supply
   - Ek 6AQ5_____v
   - ek 6AQ5_____mv (remove OA3 to read)
   - EK 6AQ5_____mv (line reg. 100-130 v line)
8. ef 807
9. ef Remaining tubes & Chopper
10. Element Potentials V5, V6, V7, V8, (turn X100 switch fully CCW)
    - Ep V5_____v Ep V6_____v E range pin 1 of V7 Ek V8_____v
    - Es V5_____v Es V6_____v _____v to _____v
    - Eg V5_____v Eg V6_____v (Set at 85V)
11. Relay Operation
    - CK2 Pull-in
    - CK1 & CK2 Pull in Relays pull-in down to_____v line.
12. Thyrite Varistors
    - Rise time to 500V_____sec.
    - Feedback (R45) current at 3 v_____ua (Plug in std. cell plug)
    - Chopper (R44) current at 3 v_____ua
13. Main Supply Initial Operation
    (Note if satisfactory, or, if trouble is encountered, state briefly)
14. Offset
    - Eo at 1.02 w/pin 7 of V7 set at minus .04v =
    - Eo at 1.02 w/pin 7 of V7 set at plus .04v = _____v
    - Difference in Eo at 1.02 (offset)_____v (.004v max.)

301E TEST RECORD

Date:_____ Serial No.:_____ Technician:_____

Output	Regulation Line	Load	Tolerance	Ripple No Load	Full Load
		Positive Ground		No Reading Above 2 mv	
500			37.5 mv		
110 100 at 0			8.25 mv		
1.02			1.5 mv		
		Floating Ground		No Reading Above 2 mv	
500			37.5 mv		
110 100 at 0			8.25 mv		
1.02			1.5 mv		
		Negative Ground		No Reading Above 2 mv	
500			37.5 mv		
10 100 at 0			8.25 mv		
1.02			1.5 mv		

Linearity

X100_____ X10_____ X1_____

X.1_____ Vernier_____

Meters

Voltmeter_____ Ammeter_____

Thyrites_____

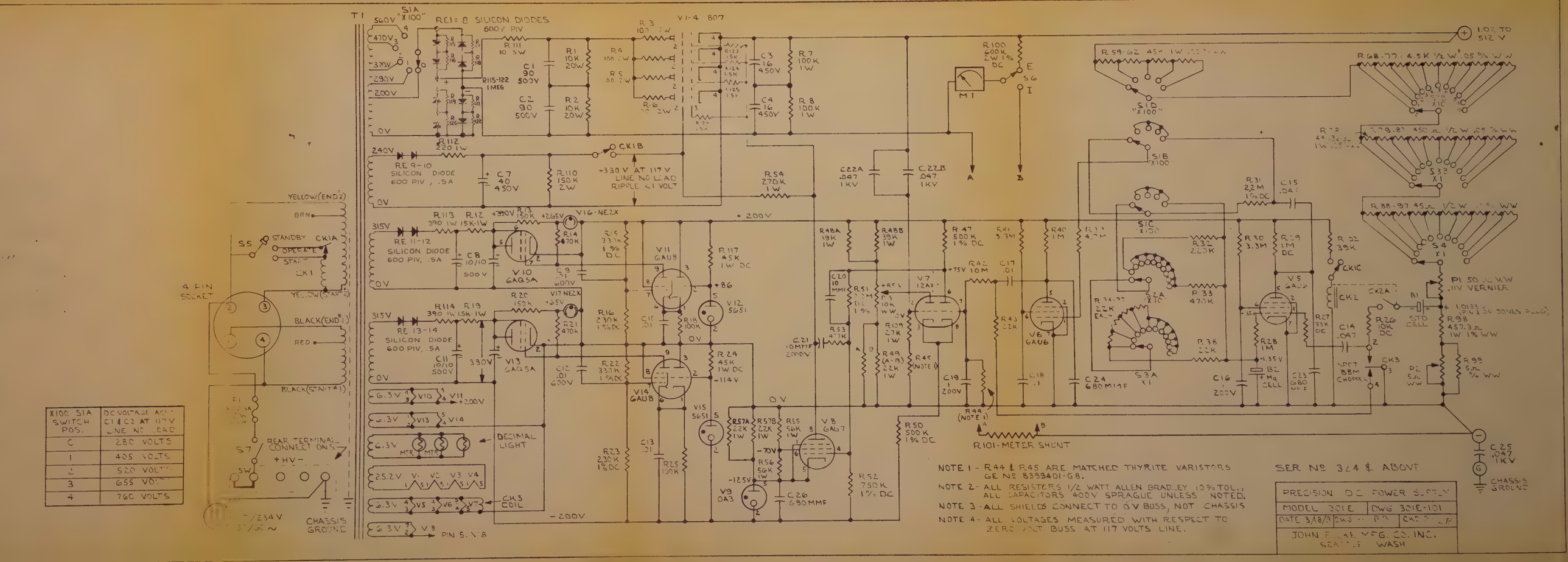
Calibration & Stability Check with K Pot

Linearity Check - Using Oil Bath Divider

Dail Setting	Deviation in ppm
500	
400	
300	
200	
100	
50	
10	
5	
1.02	

Check Stability at Max. Eo in Pos. Po
No Load, 120V Line

Time	K-Pot	Polarity



NOTE 1 - R44 & R45 ARE MATCHED THYRITE VARISTORS GE Nº B399401-GB.

NOTE 2 - ALL RESISTORS 1/2 WATT ALLEN BRADLEY 10% TOL., ALL CAPACITORS 400V SPRAGUE UNLESS NOTED.

NOTE 3 - ALL SHIELDS CONNECT TO 0V BUSS, NOT CHASSIS

NOTE 4 - ALL VOLTAGES MEASURED WITH RESPECT TO ZERO VOLT BUSS AT 117 VOLTS LINE.

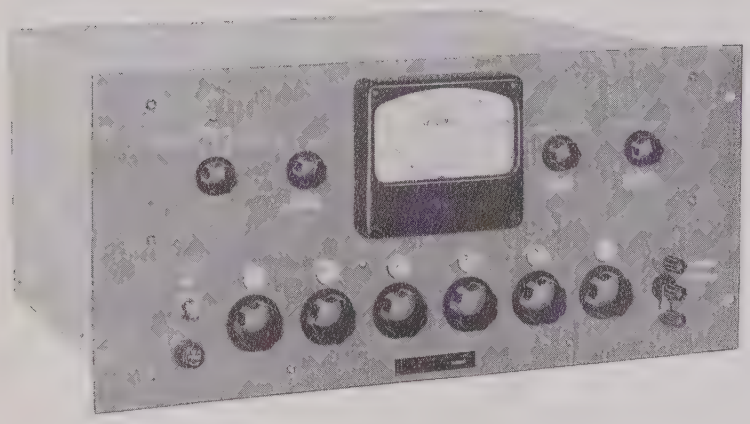
SER Nº 314 & ABOVE

PRECISION DC POWER SUPPLY	
MODEL 301E	DWG 301E-101
DATE 3/18/3	DWG -- REV CHG'S -- REV
JOHN FLUKE MFG. CO. INC. SEATTLE WASH	

FLUKE

TECHNICAL DATA

351A POWER SUPPLY



FEATURES

- High Accuracy and Stability
- Close regulation of Output
- 0.1 Microampere Current Resolution
- Six Dial in-line Readout, Reads Directly in Milliamperes
- Rapid Selection of Output Current
- Two Over-voltage Protection Circuits

APPLICATIONS

Calibration and Testing of -

1) Instruments
2) Microammeters and Milliammeters
3) Semiconductors
4) Torque Motors
5) Bolometers
6) Sensitive DC Relays

DESCRIPTION

Model 351A is a multi-purpose constant current power supply which provides a closely regulated output of 1.0 microamperes to 100 milliamperes in 0.1 microampere increments. Current output level is easily set with six decade switches arranged to provide convenient in-line readout with illuminated decimal point.

A standard cell reference and chopper stabilization of the DC amplifier impart to the 351A excellent output current stability and almost complete isolation from effect of line voltage and load resistance changes.

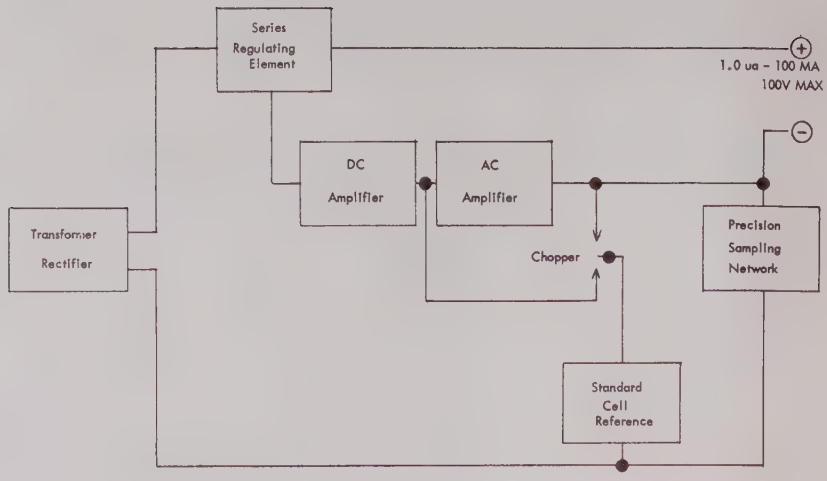
Unique barrier construction isolates the standard cell and precision wirewound resistor current sampling strings from all heat generating elements.

A voltage limiting circuit in the Model 351A provides maximum protection when used to calibrate meters. With the limiter in, the output voltage will not rise above 600 millivolts. With the limiter out, the instrument automatically is placed in standby condition if the output voltage attempts to rise above 120 volts.

Highest quality components are used to insure trouble-free operation.

MODEL 351A

SIMPLIFIED BLOCK DIAGRAM



ELECTRICAL SPECIFICATIONS

INPUT VOLTAGE: 117/220/234 volts ±10%, 50-60 cps, single phase.

INPUT POWER: 125 watts fully loaded, 75 watts standby.

OUTPUT CURRENT: 1.0 UA - 100 MA in 0.1 UA steps.

OUTPUT VOLTAGE: 0 - 100 volts maximum.

VOLTAGE LIMITER: Panel switch selected: limits output voltage to 600 MV providing automatic protection for meter calibration (calibration accuracy specification applies only up to 300 MV with voltage limiter circuit operative).

OVER-VOLTAGE PROTECTION: Over-voltage circuit automatically places unit in standby condition when output voltage tends to rise above 120 volts.

OUTPUT POLARITY: Positive or negative grounded, or floating (output polarity may be reversed with front panel switch).

OUTPUT CONNECTORS: Front panel insulated binding posts on 3/4" centers and terminal strip on rear skirt.

REGULATION vs. LINE: 0.01% or 0.1 microampere, whichever is greater, for 10 volt line change.

REGULATION vs. LOAD: 0.01% or 0.1 microampere, whichever is greater, for load resistance change from zero to maximum.

STABILITY: 0.005% per hour after short warmup, 0.01% per day.

RIPPLE: 0.05% plus 1.0 microampere. (RMS)

MAXIMUM LOAD RESISTANCE: 50 K ohms (maximum load resistance at any current setting, must be consistent with maximum voltage allowable across load).

CALIBRATION ACCURACY: 0.05% +0.5 microampere.

CURRENT RESOLUTION: 0.1 microampere.

READOUT: 6 dial in-line with illuminated decimal point, reads directly in milliamperes.

METER: 4-1/2" rectangular mounted with switch for selectively reading voltage and current.

MECHANICAL SPECIFICATIONS

DIMENSIONS: 8-3/4" rack panel, 19" wide, 14" deep. Equipped with resilient feet for bench use.

WEIGHT: 35 pounds.

PRICE: $845.00, f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U. S. A.

Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 351A

TEST PROCEDURE

A. VISUAL INSPECTION

1. Check front panel engraving for accuracy and quality. Check that 117-234V connection decal, rear fanning strip identification decal, and tube location decal are attached to instrument.

2. Check front panel controls to insure that all knobs are tight and properly oriented, and that moving parts do not bind.

3. Check placement of all components on front panel and on main chassis, with emphasis on proper attachment and quality of workmanship.

4. Check all solder joints.

5. Check appearance of all harnesses, with emphasis on proper routing and quality of workmanship.

B. PRELIMINARY CHECKS

1. Resistance.

   (a) Remove shorting link between negative binding post and G post. Resistance between negative binding post and chassis and positive binding and chassis must be infinite.

   (b) Measure resistance across C1. Should be 150K.

   (c) Measure resistance across C6. Should be 150K.

   (d) Measure resistance across C7A and C7B. Should be greater than 500K.

   (e) Measure resistance across C11A and C11B. Should be greater than 500K.

   (f) Turn front panel dials to 0-0-0-0-1. Measure resistance from negative binding post to internal negative. Should be 1 M. Rotate last dial CW, noting that resistance changes to 500K, 333K, 250K, 200K, 167K, 143K, 125K, 111K, and 100K. Then rotate next to last dial CW noting that resistance changes to 50K, 33K, 25K, 20K, 16.7K, 14.3K, 12.5K, 11.1K, and 10K. Rotate third dial CW noting that resistance changes to 5K, 3.3K, 2.5K, 2K, 1.67K, 1.43K, 1.25K, 1.11K and 1.0K. Rotate second from left dial CW noting that resistance changes to 500, 333, 250, 200, 167, 143, 125, 111, and 100. Rotate left dial CW noting that resistance changes to 60, 43, 35, 30, 26.7, 24.3, 22.5, 21.1 and 20.

   (g) Check that there is continuity between front panel binding posts and appropriate terminals of rear fanning strip.

2. Input Power.

   Set power variac to 0 and turn instrument on. Slowly increase variac setting while monitoring input power. Input power should never exceed 70 watts. Increase variac setting to 117V. Input power should be 55 to 65 watts. Monitor input power while continuing preliminary checks and be alert for smoke or other evidence of trouble. Increase variac setting to 130V and check for any failure. Return variac setting to 117V for remaining checks.

3. Voltage measurements (with respect to internal negative).

   (a) +200V Aux:
   Ek V5 (pin 2, 6AQ5, should be +200V)

   (b) -200V Aux:
   Pin 2 of V13 should be -200V

   (c) Screen supply (change negative lead of voltmeter to positive binding post).
   Voltage across C6 should be 320V

4. Unplug standard cell. Check that CK2 and CK3 pull in by depressing the large blade of CK1 nearest the heat barrier. CK2 and CK3 should drop out when this blade is released.

5. Measure voltage from junction of R62 and R63 to internal negative. Should be 0.02V.
   Connect standard cell.

6. Main supply initial operation
   Set current controls to 0-9-9-9-10 (10ma)
   Set voltage limiter to IN
   Set meter function to I
   Rotate standby, operate, start switch (S1) to start and release. Meter should indicate approximately 10 ma and light over OPERATE should be on.
   Turn meter function to E. Meter should read 1V.

C. BAKE

Switch voltage limiter to IN. Turn S1 through START to OPERATE. Let instrument operate at normal line voltage for not less than 24 hours with 100 ma dialed.

D. PRE-CALIBRATION CHECKS

1. +200V Aux:

   (a) Eb V5 (6AQ5, pin 5, 6) should be 350V

   (b) ep V5 should be less than 1V

   (c) ek V5 should be 5 mv or less

   (d) Line voltage at which +Aux. drops out. Should be less than 100V.

   (e) Vary input voltage from 100-130V. Ek of V5 should be less than 400 mv.

2. -200V Aux:

   (a) Eb V9 (6AQ5, pin 5, 6) should be 350V.

   (b) ep V9 should be less than 1V.

   (c) ek V9 should be 5 mv or less.

   (d) Line voltage at which Aux. drops out. Should be less than 100V.

   (e) Vary input voltage from 100-130V. Ek of V9 should be less than 400 mv.

3. (a) Check DC at plates of 6CA7's. Should be 250V.

   (b) Check AC at plates of 6CA7's. Should be less than 4V.

4. Check plate and screen voltages of V17 and V16.
   Check plate, grid, and cathode voltages of V15, V14 and V19.

5. Reference Circuit:
   Check voltage at V18, pin 2, 4, 7. Should be 83-86V.
   Check regulation of voltage at this point for 100-130V line change.
   Must be less than 10 mv.

6. AC amplifier minimum adjustment:
   Connect AC VTVM from plate (pin 5, V16) to internal negative. Adjust P1 for minimum reading. Should be less than 9V, about 3V.

7. Calibration adjustment:
   Connect 10 ohm resistor across positive and negative binding posts. Switch voltage limiter to OUT. Dial 9-9-9-9-10 and adjust P2 so that voltmeter (801) or potentiometer across 10 ohm resistor reads 1.00000V.

8. Linearity:
   Check voltage (with potentiometer) across 10 ohm resistor as first three dials are rotated to zero. Maximum error should be less than 0.03%. Use 100 ohm resistor for 10 ma and lower.

9. Meter Calibration:

   (a) With meter function turned to I and 100 ma dialed, adjust meter shunt for full scale. NOTE: When making adjustment, switch unit to standby.

   (b) Check linearity by dialing 90, 80, 70, 60, 50, 40, 30, 20, 10 ma. Error should not be greater than 1-1/2 small divisions.

   (c) Switch meter function to E and dial 100 ma with 1K load. Meter should read 100V. Check linearity by changing output current to 90, 80. 70, 60, 50, 40, 30, 20, 10 ma. Error should be less than 1-1/2 small divisions.

10. Check over-voltage at which CK4 pulls in. Dial 10 ma with 10K load. Increase load current in steps of 0.1 ma. CK4 should pull in at 11 ma to 12 ma.

    PUT COVER ON.

11. Line Regulation:
    Use 10 ohm resistor and potentiometer, 100 ohm for 10 ma and lower. Check reading for 100-117-130V line. Change from 100-130V should be less than 0.02%. Take readings at 100 ma, 10 ma, 1 ma, 0.1 ma.

12. Load Regulation:
    Connect variable load resistance in series with 10 ohm (or 100 ohm for 10 ma and lower) resistor. Check voltage across fixed resistor and ripple across binding posts as specified in test report.

13. Voltage Limiter:
Use 10 ohm resistor as load, and potentiometer. Dial 30 ma and compare reading with VOLTAGE LIMITER OUT to reading with VOLTAGE LIMITER IN.

E. FINAL CALIBRATION AND STABILITY

1. Recheck AC amplifier minimum adjustment as in step D-6.

2. Put cover on. Reset P2 as in step D-7.

3. Check stability of 100 ma setting for 2 hours.

351A

DC VOLTAGES/ZERO BUS

PIN

	1	2	3	4	5	6	7	8
V-1/-2			215 ± 10%	Across C-6 250 ± 10%	-12 to -20			
V-14	125 ± 5%			-115 to -130	-125	-67 to -73		-12 to -20
V-15	60-70	+.45 to +.55				60-75	+.2 to +.8	
V-16	-1.16				55-72	30-45		
V-17	-1.2				55-72	30-45		

351A Test Report

Date _____ Serial No. _____

Technician _____

A. VISUAL INSPECTION	Limits	Reading	Remarks
1. Engraving, Decals	OK		
2. Controls	OK		
3. Components	OK		
4. Solder Joints	OK		
5. Harnesses	OK		
B. Preliminary Checks			
1. Resistance Readings			
a. Neg. to G Post	Infinite		
b. Across C1	150K ± 5%		
c. Across C6	150K ± 5%		
d. Across C7A & B	MT 500K		
e. Across C11A & B	MT 500K		
f. Sample Resistors	See Text		
g. Binding Posts to Term. strip continuity	0 ohm		
2. Input Power	55-65 Watts		
3. Voltage Measurements			
a. Filament Regulator	-11.5 to -12.9V		
b. +190V Aux.	181 to 220V		
c. -190V Aux.	-181 to - 220V		
d. Screen supply	305 to 335V		
4. CK2 & CK3 Pull-in	OK		
5. .02V Reg.	-.018 to -0.22V		
6. Main Supply Operation	OK		
7. Meter Cal.			
a. Set Shunt for F.S. 1	LT 1 sd		

B. Preliminary Checks (con'd)	Limits	Reading	Remarks
b. I Scale Linearity	LT 1-1/2 sd		
c. E F.S.	LT 1-1/2 sd		
8. Load Voltage for CK4 Pull-in	105-125V		
9. AC Amp. Min. Adj.	LT 3-9V		
10. Ripple Adjust, 1 ua, 50K Load	LT 25 mv		With shorting link ON or OFF, with Line Cord Connected to ground
C. Bake (24 Hours Minimum)	None		

11. Linearity (Grounded Line Cord, Link ON, Read with K-pot)

Dial Settings	Load Resistor	Limits	Reading
100 ma	10 ohm	0.99970-1.00030V	
90 ma	10 ohm	0.89973-0.90027V	
80 ma	10 ohm	0.79976-0.80024V	
70 ma	10 ohm	0.69979-0.70021V	
60 ma	10 ohm	0.59982-0.60018V	
50 ma	10 ohm	0.49985-0.50015V	
40 ma	10 ohm	0.39988-0.40012V	
30 ma	10 ohm	0.29991-0.30009V	
20 ma	10 ohm	0.19994-0.20006V	
10 ma	10 ohm	0.09997-0.10003V	
10 ma	100 ohm	0.99970-1.00030V	
9 ma	100 ohm	0.89973-0.90027V	
8 ma	100 ohm	0.79979-0.80024V	
7 ma	100 ohm	0.69979-0.70021V	
6 ma	100 ohm	0.59982-0.60018V	
5 ma	100 ohm	0.49985-0.50015V	
4 ma	100 ohm	0.39988-0.40012V	
3 ma	100 ohm	0.29991-0.30009V	
2 ma	100 ohm	0.19994-0.20006V	
1 ma	100 ohm	0.09997-0.10003V	
1.0 ma	1000 ohm	0.99970-1.00030V	
.9 ma	1000 ohm	0.89970-0.90030V	

11. Linearity (Continued)

Dial Settings	Load Resistor	Limits	Reading
.8 ma	1000 ohm	0.79970-0.80030V	
.7 ma	1000 ohm	0.69970-0.70030V	
.6 ma	1000 ohm	0.59970-0.60030V	
.5 ma	1000 ohm	0.49970-0.50030V	
.4 ma	1000 ohm	0.39970-0.40030V	
.3 ma	1000 ohm	0.29970-0.30030V	
.2 ma	1000 ohm	0.19970-0.20030V	
.1 ma	1000 ohm	0.09970-0.10030V	
.10 ma	10,000 ohm	0.99700-1.00300V	
.09 ma	10,000 ohm	0.89700-0.90300V	
.08 ma	10,000 ohm	0.79700-0.80300V	
.07 ma	10,000 ohm	0.69700-0.70300V	
.06 ma	10,000 ohm	0.59700-0.60300V	
.05 ma	10,000 ohm	0.49700-0.50300V	
.04 ma	10,000 ohm	0.39700-0.40300V	
.03 ma	10,000 ohm	0.29700-0.30300V	
.02 ma	10,000 ohm	0.19700-0.20300V	
.01 ma	10,000 ohm	0.09700-0.10300V	
.01 ma	100,000 ohm	.97000-1.03000V	
.009 ma	100,000 ohm	.87000-.93000V	
.008 ma	100,000 ohm	.77000-.83000V	
.007 ma	100,000 ohm	.67000-.73000	
.006 ma	100,000 ohm	.58000-.62000	

11. Linearity (Continued)

Dial Settings	Load Resistor	Limits	Reading
.005 ma	100,000 ohm	.48000-.52000V	
.004 ma	100,000 ohm	.38000-.42000V	
.003 ma	100,000 ohm	.29000-.31000V	
.002 ma	100,000 ohm	.19000-.31000V	
.001 ma	100,000 ohm	.09000-.31000V	
.001 ma	1,000,000 ohm	.90000-1.1000V	
.0009 ma	1,000,000 ohm	.81000-.99000V	
.0008 ma	1,000,000 ohm	.72000-.88000V	
.0007 ma	1,000,000 ohm	.63000-.77000V	
.0006 ma	1,000,000 ohm	.54000-.66000V	
.0005 ma	1,000,000 ohm	.45000-.55000V	
.0004 ma	1,000,000 ohm	.36000-.44000V	
.0003 ma	1,000,000 ohm	.27000-.33000V	
.0002 ma	1,000,000 ohm	.18000-.22000V	
.0001 ma	1,000,000 ohm	.19000-.11000V	

12. Line Regulation (power line grounded, Link ON)

	Line	Output Volts	Limit
100 ma.			
10 ohm Load Resistor	130V	_____	
	100V	_____	
	Difference	_____	LT .00025V
10 ma.	130V	_____	
100 ohm Load Resistor	100V	_____	
	Difference	_____	LT .0025V

12. Line Regulation (power line grounded, link ON) (Continued)

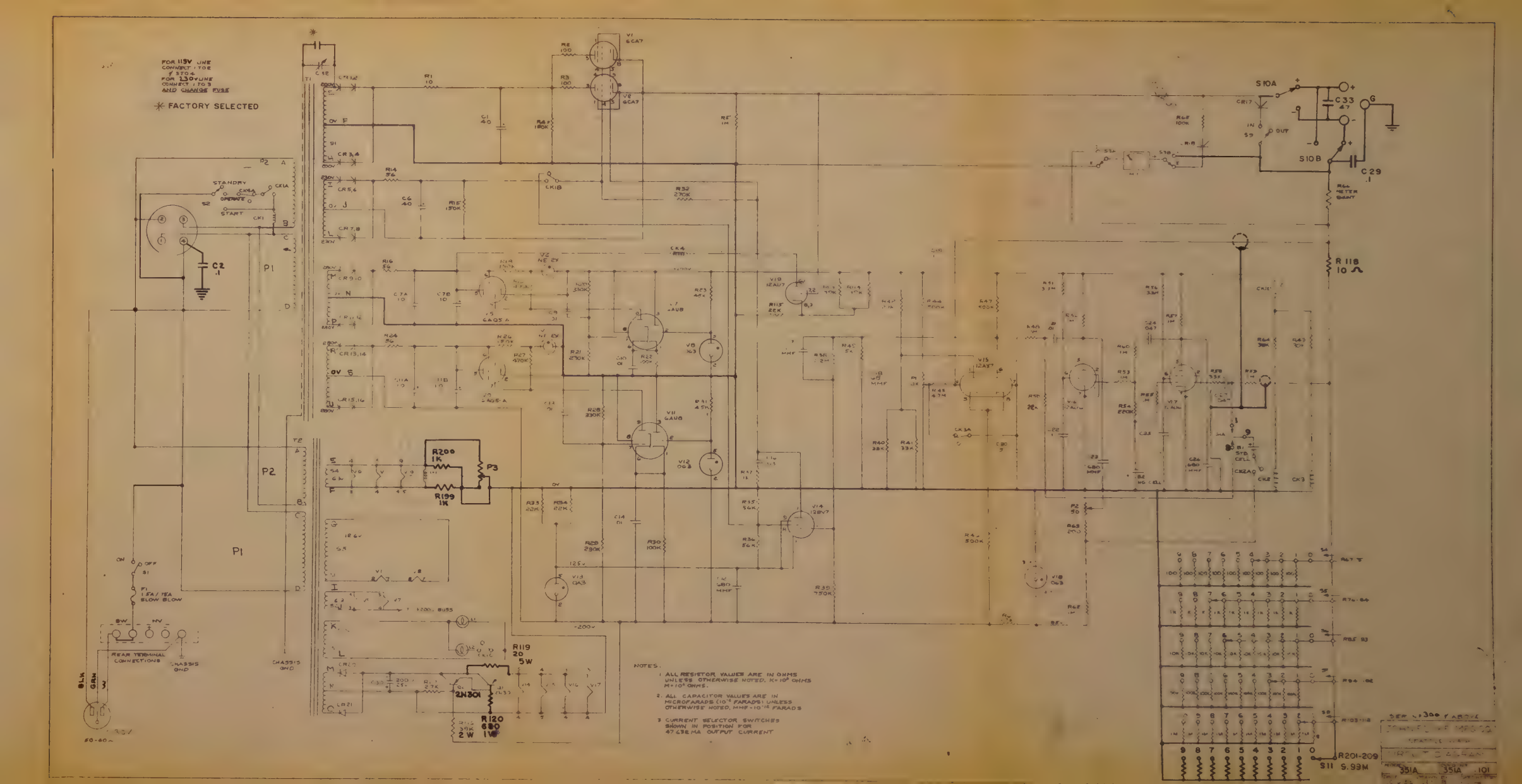
1 ma 1000 ohm Load Resistor	130V 100V Difference	_____ _____ _____	LT .00025V
0.1 ma 10K ohm Load Resistor	130V 100V Difference	_____ _____ _____	LT .00025V
0.01 ma 10K ohm Load Resistor	130V 100V Difference	_____ _____ _____	LT .000025V

13. Load Regulation (AC line cord grounded)

100 ma	Load	E. Floating	E. Gnd	Difference	Ripple
	0	_____	_____	(LT .0002V)	
	1K	_____			(LT 50 mv)
	Difference	_____ (LT .00007V)			
10 ma	0	_____	_____	(LT .0002V)	
	10K	_____			(LT 50 mv)
	Difference	_____ (LT .00007V)			
1 ma	0	_____	_____	(LT .0002V)	
	50K	_____			(LT 50 mv)
	Difference	_____ (LT .00007V)			
0.1 ma	0	_____	_____	(LT .0002V)	
	50K	_____			(LT 50 mv)
	Difference	_____ (LT .00007V)			

14. Stability (Allow 1 hour warm up) 2 hour test	Time	0.00005V per hour

15. Final Calibration and Stability	Reading	Limit
1. Reset Cal as in D7	_____	.99970-1.0003
2. Reset shunt		1% of FS


FOR 115V LINE CONNECT 1 TO E Y 3 TO 4
FOR 230V LINE CONNECT 1 TO 3 AND CHANGE FUSE
✳ FACTORY SELECTED
STANDBY
OPERATE
START
P1
P2
C2 .1
S1
F1 1.5A/ 75A BLOW BLOW
ON
OFF
REAR TERMINAL CONNECTIONS
CHASSIS GND
BLK
GRN
WHT
50-60~
115V
230V
0V
126V
-200V
V1 6CA7
V2 6CA7
V3 6AQ5A
V4 6AQ5A
V5 6AU8
V6 6X3
V7 6AU8
V8 6X3
V9 6AU8
V10 6X3
V11 6AU8
V12 6X3
V13 0A3
V14 12BY7
V15 12AY7
V16 12AU7
V17 12AU7
V18 6X3
V19 12AU7
V20 NE 2X
V21 NE 2X
R200 1K
R199 1K
P3
R119 20 5W
2N301
R120 680 2W 1%
S10A
S10B
C33 47
C29 .1
R118 10Ω
R201-209
S11 S.93M
NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED. K=10³ OHMS M=10⁶ OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS (10⁻⁶ FARADS) UNLESS OTHERWISE NOTED, MMF=10⁻¹² FARADS
3 CURRENT SELECTOR SWITCHES SHOWN IN POSITION FOR 47.638 MA OUTPUT CURRENT
SER. NO 300 & ABOVE
351A
351A -101

FLUKE

TECHNICAL DATA

407 POWER SUPPLY

MODEL 407 HIGH RESOLUTION DC POWER SUPPLY

A GENERAL PURPOSE,

LOW COST

PRECISION POWER SOURCE

DESCRIPTION

The Model 407 Power Supply is a moderately priced, versatile laboratory supply with high resolution and regulation. Through the use of silicon rectifiers, printed circuitry and light-weight aluminum construction, the size and weight have been kept to the absolute minimum.

Extreme stability is due in large part to the use of highest quality precision wirewound resistors in sampling circuits and at all critical points. All potentiometers are likewise wirewound and the reference tube is an aged unit operated at constant current. Accordingly, the voltage controls are calibrated and may be used for the direct calibration of multimeters and panel instruments. A high voltage "OFF" position is provided on the meter circuit switch for disconnecting the high voltage from main output posts without affecting other outputs.

FEATURES

HIGH STABILITY: 0.01% or 50 mv per hour. 0.05% or 250 mv per day.

HIGH REGULATION: 0.01% or 50 mv for 10% change in line voltage. 0.01% or 50 mv for load current change of 0 to 300 ma.

HIGH ACCURACY: Better than 0.5% for the 0-500 v dial.

HIGH RESOLUTION: 2 mv over entire range using 0 to 0.55 v control.

HIGH FLEXIBILITY: Dual bias and filament outputs, wide output range of voltage and current, and ease of operation make this a very versatile laboratory aid.

LOW OUTPUT IMPEDANCE: Less than 0.5 ohm DC to 100KC at maximum output.

LOW MAINTENANCE: Use of silicon rectifiers, printed circuitry, and generous de-rating of components increases reliability and decreases maintenance of this instrument.

LOW RIPPLE: Less than 1 mv RMS.

SPECIFICATIONS

INPUT VOLTAGE: 117 or 234 volts, 50/60 cycles.

INPUT POWER: 425 watts fully loaded, 100 watts standby.

MAIN OUTPUT VOLTAGE: 0 to 555 volts DC.

MAIN OUTPUT CURRENT: 0 to 300 milliamperes.

REGULATION: 0.01% or 50 millivolts for 10% change in line voltage. 0.01% or 50 millivolts for load current change from 0 to 300 milliamperes.

OUTPUT IMPEDANCE: Less than 0.5 ohm DC to 100 KC at maximum output.

STABILITY: 0.01% or 50 millivolts per hour. 0.05% or 250 millivolts per day.

RIPPLE: 1 millivolt RMS or less.

VOLTAGE RESOLUTION: 2 millivolts over entire range via 0 to 0.55 v control.

VOLTAGE CONTROLS:
0 to 500 volts, ten 50 volt steps.
0 to 55 volts, smoothly variable.
0 to 0.55 volts, smoothly variable.

CALIBRATION ACCURACY: Better than 0.5% as set by 500 v dial.

OUTPUT POLARITY: Either positive or negative side of main output may be grounded, or both sides may be left floating. Two supplies may be series connected with either side of either supply grounded.

METER: Illuminated 4-1/2 inch square meter with MTR. CKT. switch for selectively reading HV output voltage, BIAS output voltage and HV output current. Switch also disconnects HV output from output binding posts when turned to extreme CCW position.

METER RANGES: 0 to 300 milliamperes. 0 to 600 volts with MTR. RANGE switch in 500 v position. 0 to 60 volts with MTR. RANGE switch in 60 v position.

AUXILIARY OUTPUTS: (DC) 0 to -250 volts and 0 to -25 volts bias supply, variable via BIAS control. Maximum current output 5 milliamperes at 250 volts. Positive side connected to negative side of main output. Line regulation 0.02%. 1 millivolt maximum ripple. Output impedance 0 to 10,000 ohms depending on setting of bias control. At 250 volt setting load regulation 0.01% for 5 milliampere load change. (AC) Two independent 6.3 volt 5 amp. outputs. Each winding insulated for 1500 volts RMS to ground.

OUTPUT CONNECTORS: All outputs brought out to binding posts on 3/4" centers. Also brought out to terminal strip at rear on rack mounting models.

MECHANICAL: Cabinet model--9-3/4" wide, 13" high, 14" deep. Weight 39 lbs. Grey wrinkle finished case. Rack mounting model--19" wide, 8-3/4" high, 16-3/4" deep. Weight 48 lbs. Smooth grey finish. Equipped with removable resilient feet for bench mounting.

PRICE: Cabinet model--$335.00 f.o.b. factory, Mountlake Terrace, Washington. Rack model--$355.00 f.o.b. factory, Mountlake Terrace, Wash.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho U.S.A.

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 407 TEST PROCEDURE

1. Visual Inspection. This inspection must be performed before the supply is connected to the power line. Check every single connection carefully. Adopt an orderly checking route and follow it every time. Use a probe to test connections. Resolder any questionable joints. Pay particular attention to the soldering of terminal lugs or eyelets on the printed circuit boards. Solder must by flowed from the lug or eyelet to the copper foil on the PCB. The mechanical connection alone is sometimes very poor electrically. Check every single solder connection on the power chassis, PCB, front panel and switches. Examine all connections to the multi-deck switches on the front panel, checking carefully for unsoldered or missing jumper wires and poorly soldered wirewound resistors. Also check placement of resistors to be certain they are not shorting to adjacent switch contacts. Make certain that the meter shunt on the meter switch is soldered at both ends before instrument is turned on. Binding posts should be checked for solid connection and make certain that the G post is tied to chassis ground by the bus wire and the negative output terminal should be permanently linked to the positive bias terminal. All front panel engraving should be checked for quality, omissions or flaws. All switch and pot knobs should be checked for indexing, spacing from panel and tightness. Check orientation of 12 diodes on power PCB against symbols on PCB.

2. Ohmmeter Check. The ohmmeter check consists mainly of checking resistance across electrolytic capacitors on both power and amplifier side of chassis. Starting on the power PCB (left side) check resistance from negative side of C2 to positive post of C2. This should read 10K. Resistance from negative of C2 to positive of C1 should increase to 20K. Leaving black lead of ohmmeter on can of C2 read resistance to positive lug of C4. Should read 85K with "0-500" switch fully clockwise. Next read resistance of positive lug of C3 leaving black lead on negative bus. This should read at least 140K. Now shift black ohmmeter lead to positive lug of C3 and read resistance across C5. Should read at least 500K.

Proceeding to amplifier PCB measure resistance across C6 (labeled C1 on PCB foil), the can at the bottom of the board. This should read 50K. Using same negative bus measure positive lug of C11. Should read 25K with BIAS pot at maximum clockwise.

This concludes ohmmeter check. Make certain all tubes are in their sockets before proceeding.

3. Preliminary Check of Operation. Set up front panel controls so that power toggle switch is "OFF", "MTR CKT" switch is in "BIAS" position, BIAS pot is fully clockwise and three voltage knobs are fully counter-clockwise. Plug line cord into variac outlet and throw toggle switch to "ON". Panel meter should light and after a few seconds meter should settle down to approximately 250V. Watch and listen for any arcing, smoking, or loud X fuse hum, if present shut

supply down and proceed with caution. If meter reads high in the neighborhood of 350V, the bias supply is failing to regulate. Check to see that 5651 (V9) is glowing. Also defective V6, V7, or V8, or their associated circuitry could be defective. If no reading at all, auxiliary winding of transformer should be checked, also selenium rectifiers (RE16, 17, 18) which could also cause a low reading. Rotate BIAS pot to zero and meter should fall to 0.

Assuming bias indications on meter are proper, turn "METER CKT" switch to "HV". Meter should indicate zero within 15 volts. If it does not, the HV output is probably not regulating due to trouble in V1, V2, V3, V4 or their associated circuitry. If meter does read roughly 0 rotate left hand voltage knob clockwise, one 50V step at a time. Meter should advance in 50V steps to approximately 500 volts. An additional 55 volt rise should result from rotating middle voltage knob maximum clockwise. If at any step, the meter jumps more than 60V on the meter there is probably an opening in the resistor string on the switch. Failure to rise at all would probably indicate failure in transformer, HV winding, secondary tap switch, silicon diodes RE1 thru RE12, or 807 circuitry. To eliminate "MTR CKT" switch miswiring, check 0-555V output posts with VTVM.

4. Screen Supply No Load. If preliminary check is satisfactorily completed, proceed with check of screen supply potentials. Set 1st voltage dial to 50V position and connect VTVM negative lead to cathode (Pin 4) of any one of three 807 sockets. Set variac at 130V line and with VTVM on 500V RANGE measure voltage on screen (Pin 2) of 807's. Should read 375V within 5%. Absence of, or low voltage at this point could be due to defective transformer, screen winding, selenium rectifiers (RE13, 14, 15 or RE45). In the event C5 shorts R45 would burn up protecting transformer and seleniums. Ripple at this point should not exceed .35V.

5. Screen Supply - 300 ma. Reset variac to 105V line and rotate 1st two voltage knobs maximum clockwise for 555 volts. Using 407 load box set on 500V position, apply load to 555V binding posts observing proper polarity and repeat DC and AC readings on screen. DC reading should be 250V within 5% and ripple should not exceed 3.5V. Load should not be applied for long periods of time since load box wattage rating is insufficient.

6. With line at 117V and all 3 voltage knobs to zero, connect black lead of VTVM to negative side of C2 or C4 and using 1500V range read DC voltage on plate caps of any one 807 tube. Reading should be approximately 280V. Now rotate 1st voltage switch observing E_p 807's. This voltage should increase on all except 1st, 3rd and 5th steps where it should remain the same as the previous step. With switch at maximum clockwise E_p 807's should be approximately 840V. The main thing to watch for is a variation from this sequence which would indicate miswiring of the transformer secondary leads on the rear deck of this switch or an open transformer tap.

7. Moving now to the amplifier circuit board on the right side of the supply, read the DC voltage across C6 in the auxiliary supply. Should be about 425V within 10%, with an AC component not to exceed 3.5V.

8. Regulation of 12AX7 Filaments. With an AC VTVM read 12AX7 filament voltage at 117V line. A convenient place to read is from pin 4 of 6AU8 to pin 7 of 9-7 ballast tube. Should be approximately 6.3V. Now vary line from 105V to 130V, recording difference in filament voltage as line is varied. Should not exceed .9V. If more, replace 9-7 ballast tube and retest.

9. ef Other Filaments. Check filament voltages on 6AQ5 (Pins 3 and 4), 6AU8 (Pins 4 and 5), and three 807's (Pins 1 and 5). 807 filaments should read within .4V of each other. Replace any tube that varies more than this from the other two. The three 807's are wired in series so individual tube filament characteristics affect the division of filament voltage between them. 807's not suitable for use in this supply may be used in the model 406 where filaments are wired in parallel.

10. With line still at 117V, check for 6.3V at auxiliary filament posts on front panel. Since these two outputs must work in series or parallel, a phase check must be performed. This can be accomplished in two ways. An oscilloscope on line sweep can be connected in identical manner to the two sets of 6.3 terminals alternately observing the phase angle on the scope. It must be identical on both sets of terminals. The second method is to bus the top two posts and the bottom two posts at the same time. There must be no sign of arcing when the second bus touched on. This check must be performed to be certain both windings have same number of turns. In addition the bottom left terminal and top right terminal must be bussed together and 12.6 volts read across the two open terminals. Any variation from these requirements indicates one of the filaments should be reversed.

11. Set BIAS 250V. Using Model 800 or 801, set up 250 volts on voltmeter dials and with BIAS control fully clockwise connect 801 to BIAS 0-250V output posts observing inverted polarity of terminals. With 801 on 1V null range, set bias output to 250V as close as possible via P1 (upper pot on the amp. PCB). Inability to set to 250V would probably be due to badly out-of-tolerance wirewound resistors R15, R16, R21 or P1.

12. Check BIAS 25V. With 250V BIAS set, use 801 to read output of 25V bias. Since this output is derived from a divider made up of 1% resistors (R31 and R32), it must read within 1% of 25V or 250 mv. If out of specs., check R31 and R32 by substitution double checking 250 setting to be sure it is properly set.

13. Reconnect 801 to 250V bias and, using 1V or .1V null range, observe bias line regulation when line is varied from 105 to 130V. This output must not vary more than 50 mv. If it does, replace V6 and V7 in this order and retest. Several 12AX7's may have to be tried.

14. Ripple must not exceed 1 mv.

15. With 801 connected as before and line set at 117V, apply a 5 ma load to 250V bias and observe load regulation. Should not exceed 25 mv.

16. Ripple not to exceed 1 mv. Excessive load regulation and ripple could indicate BIAS control is not fully clockwise.

17. Using ripple meter, reduce Variac to point where bus supply loses control and record point at which control is regained as line is slowly raised. Bias supply must control below 100V line.

18. Meter Mechanical Zero. Rotating BIAS control fully counter-clockwise to zero and with "MTR CKT" switch in BIAS position adjust mechanical zero of panel meter via the screwdriver adjust below the meter glass. Any other setting of the "MTR CKT" switch can cause erroneous zero setting as long as supply is switched on.

19. Set 500V and 0V. To set the main supply output, set up 499.9 10 on 801 and turn 1st voltage knob on 407 fully clockwise. Other two voltage knobs must be fully counter-clockwise. Using P2, the lower pot on the amp. PCB, adjust for null on the 801 within 100 mv using 10V first, then 1V null range. This pot adjust can change the output about 50 volts. Now turn 1st voltage knob on 407 fully ccw and set up 0V on 801. Using 1V null range observe error. A positive voltage of about 100 mv is usually found at this stage. Assuming this is the case, trim P1, the upper pot used for bias calibration to give a slightly negative zero reading (about 60 to 100 mv). Now return to previous 500V setup and observe that this reading must be touched up again since it was lowered by preceeding zero adjustment. Be sure lower pot is used for 500 settings and upper pot is used for 0 settings. This procedure should be repeated until 500V setting is within approximately 100 mv and zero is within about 20 mv, preferrably negative. Return to bias output and read it to be certain it is still within 1 volt of 250. Do not readjust this output if it is within 1 volt and 0 and 500 volts were set successfully.

Inability to set these outputs could be due to a badly out-of-tolerance wirewound resistor R33 through R44 or P2. R15, R16, R21, and P1 in bias supply could also cause difficulty at this point.

20. After setting 500V and 0V linearity of resistors on 0-500V switch must be checked (R33 - R42). Starting at 0, note variation from setting using 801 on 1V null range. Check each 50V step on the switch noting variation from previous reading. Variation for each 50V step must not exceed .25% or 125 mv. Any 50V step that is out of tolerance indicates that the wirewound resistor just switched into the sample resistor string should be replaced.

21. Check Range of 55V Control. Set all voltage knobs at zero initially and, using 801 on 1V range set 0V output via the upper pot on the PCB as close as possible. Now slowly rotate 0-55 control clockwise to determine when wiper

starts onto winding as evidenced by an increase in voltage on 801. When this point is found, using an Allen wrench, loosen the knob set screw and orient knob so that pointer is on zero as wiper is just about to start onto winding. Tighten knob and recheck setting. Now rotate this control to exactly 50 on panel engraved index. Reading on 801 should be within 4% of 50 volts or 2 volt. If it is not, replace pot after double checking zero and 50.

22. Check Range of .55V Control. This control should be checked similarly, however, the main concern in this case is that total range of pot should be .55V within 4% or 22 mv.

23. Check HV OFF Position of MTR CKT Switch. Using 801, make certain there is absolutely no output when MTR CKT switch is rotated ccw to HV OFF position. To do this set 407 output to 500V, for instance, and switch to HV OFF. 801 set up for zero and 1V null should indicate absolutely no output. If there is any voltage output, look for miswiring of MTR CKT switch, particularly the rear inboard section which should completely break the circuit to the positive binding post.

24. Check Line Regulation 500V E_o, Line 105/130V, Tolerance 50 mv. To check regulation vs. line, set output of 407 to roughly 500V and using 801 on 1V null range observe output variation when line is varied from 105 to 130 volts. Should not exceed .01% or 50 mv. If in excess of this try new 12AX7 (V5) until a tube is found that will regulate satisfactorily. Other causes of poor line regulation are poor line regulation of bias supply or poor 12AX7 filament regulation due to bad 9-7 ballast tube.

25. Check Load Regulation 500V E_o, 0-300 ma, 50 mv. To check load regulation of 407 use previous setup at 117V line and, with 801 nulled on 1V range, apply 300 ma load to output posts of 407 and note output variation. Must not exceed.01% or 50 mv. Failure to stay within 50 mv could be caused by low gain in 6AU8 (V4) stage. Try a new tube in this position and retest. Another reason for poor load regulation indications could be due to hookup at output posts. The slightest resistance in hookup to point where 801 is monitoring output could, under load, give a false indication of load regulation when 801 is actually measuring IR drop in plugs or connectors feeding load. Loss of control when load is applied would indicate defective diodes, 807's, or poor solder connection in output path.

26. Check Ripple at 500V E_o, 105/130V Line < 1 mv. Connect ripple meter to output posts and note ripple as line is varied from 105V to 130V. Must not exceed 1 mv at any time. "G" post on front panel should be connected to earth ground for lowest ripple. High ripple is usually caused by leakage in 12AX7 (V5). If V5 is replaced line regulation must be rechecked. Shielded feedback capacitor (C10), if defective or not properly shielded, or shield not grounded to chassis ground could cause excessive ripple. Tranformer shield termination should be to main supply negative bus (can of C2 and C4 on PWR PCB) for lowest ripple.

35. Meter Accuracy 600V Range. Now that supply is calibrated well within .5%, its panel meter and meter divider can be checked. With MTR CKT switch in HV position, set 407 to 500V output. Recheck mechanical zero of meter by method previously described then see if meter reads within 2% of output voltage. If not, meter divider resistor (R9) should be checked by substitution. If R9 proves good and there is over 2% error, meter should be replaced with a new one.

36. Meter Accuracy 60V Range. Set output to 50 volts via 1st step on 0-500 switch. Next hold MTR RANGE switch to 60V position and see if meter reads within 2% of 50V. If not, the meter divider resistor (R8) must be out of tolerance since it was proved in the previous step that the meter movement was within 2% at the same point on the meter scale. Test R8 by substitution.

37. Stability Run. The supply has now passed all except long and short term stability check. Put supply in a case to retain heat and protect wirewound resistors from drafts and run steadily for 5 hours at 500 volts checking the output once each hour with 801. Supply must settle down to less than .01% or 50 mv per hour drift and less than .05% or 250 mv total drift after 30 minute warmup period. If instability is evident the 12AX7 (V5) is probably at fault as long as bias remains steady. If both bias and main E_o are unstable the 5651 (V9) is probably causing the trouble. If 12AX7 is changed, ripple, line regulation and load regulation should be spot checked again at 500V E_o.

38. Final Calibration 0-500 and MA Shunt. After completing stability run, and before supply is switched to a lower output or turned off, 500V and 0V calibration must be rechecked and adjusted via P1 and P2 if necessary. Zero volts should be minus 40 to -60 mv HOT and 500V should be ±100 mv HOT.

39. At this time the milliammeter shunt should be trimmed if necessary after rechecking mechanical zero.

40. Button Up. The supply having passed all tests should now be given a final look for any discrepancies which were overlooked before. Tube clamps on 807's should be closed, all tubes snug in their sockets, shunt lead trimmed to within 1/2" and excess and all components and leads dressed to clear case.

Both printed circuit boards should be sprayed with KRYLON moisture proofing, taking care to shield switches and paintwork from spray. All tapes on castings, etc., should be removed and supply put permanently into case. Two bolts inserted through rear casting of case secure chassis in case. The top bolt should have a plastic cord holder under its head. Fuse size (5 amp.) should be stamped directly below fuse holder on chassis.

The power supply is now ready to ship.

407 CHANGE SCHEDULE

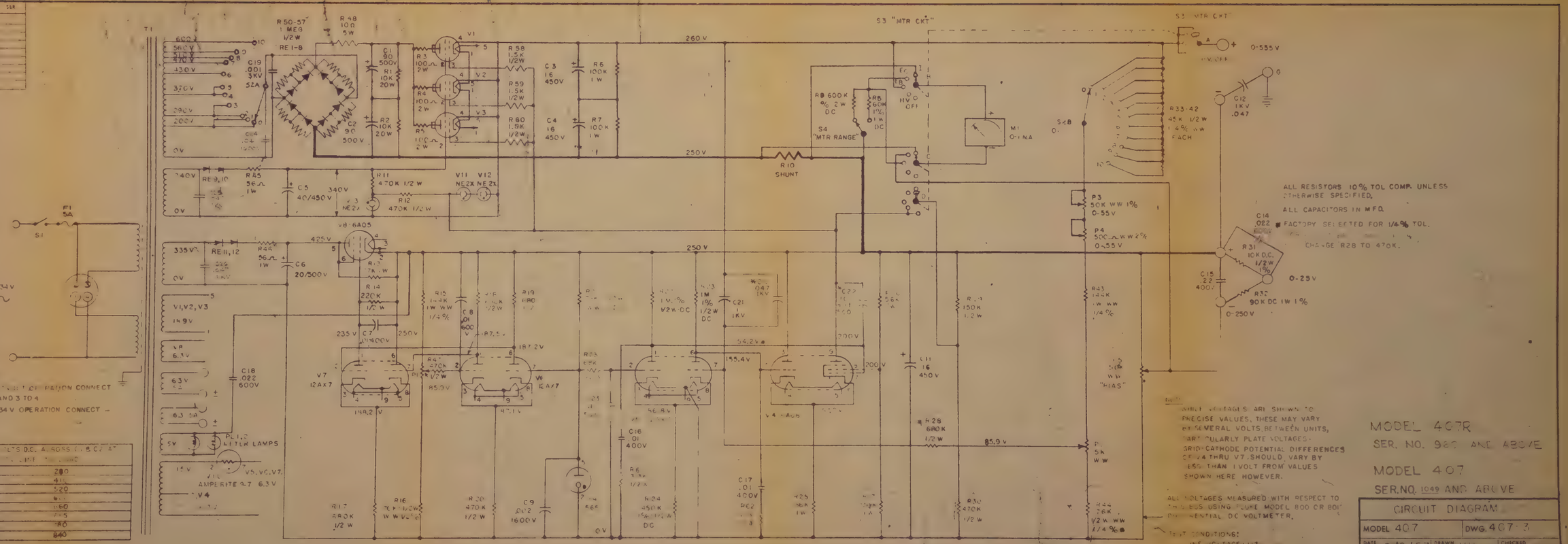
CHANGE NUMBER	DATE	DESCRIPTION	STARTING SERIAL NO.
1.	11/12/59	RE10 diodes 600 PIV replace RE6 diodes PIV 400V	514
2.	12/14/59	Delete 1 RE10 from each leg of bridge plus add 1 - 1 meg 1/2W carbon resistor across each and every diode to act as voltage divider to protect the diodes.	514

407 TEST RECORD

Serial Number				
1. Ohmeter Check				
2. Visual Inspection				
3. Preliminary Check of Operation				
4. Screen Supply - no load Ebb (375v-5%)				
50v Eo at 130v line ebb(1/t - 35v)				
5. Screen Supply - 300 ma Ebb(250v-5%)				
550v Eo at 150v line ebb(1/t 3.5v)				
6. HV Tap Check via Ep 807				
7. Aux. Supply - no load Ebb(425v-5%)				
at 117v line ebb(1/t 3.5v)				
8. Line Reg. 12AX7 ef 105/130 (1/t .9v)				
9. ef V1, V2, V3, V4, & V8 (6.3v-5%)				
10. ef 6.3v Panel Post at 117v (6.3v-5%)				
bus bot. left to top right (12.6v-5%)				
11. Set Bias -250v				
12. Check Bias -25v (within 250mv)				
13. Reg. Bias Line 105/130 (50mv)				
14. eo Bias 105/130 (1/t 1mv)				
15. Reg. Bias Load 5ma at -250v (25mv)				
16. eo Bias at 5 ma (1/t 1mv)				
17. e Line Minimum Bias (1/t 100v line)				
18. Set meter mechanical zero				
19. Cal. Eo at 500v & Ov				
20. Linearity of 0-500sw. (125mv per step)				
21. Range of 0-55v pot (1% at 50v)				
22. Range of 0-.55v pot (1% at full rot)				
23. Check "HV OFF" of "MTR CKT" sw.				
24. Reg. 500v Eo Line 105/130 (50mv)				
25. Reg. 500v Eo at 300ma (50mv)				
26. eo 500v Eo 105/130 (1/t 1mv)				
27. eo 500v Eo at 300ma (1/t 1mv)				
28. eo 500v Eo Pos. & Neg. gnd. (1/t 1mv)				
29. Calibrate Milliammeter Shunt				
30. Reg. 10v Eo Line 105/130 (50mv)				
31. Reg. 10v Eo Load 300ma (50mv)				
32. eo 10v Eo 105/130 (1/t 1mv)				
33. eo 10v Eo at 300ma (1/t 1mv)				
34. Reset Eo at 500v & Ov				
35. Check Meter Accuracy 600v range (2%)				
36. Check Meter Accuracy 60v range (2%)				
37. Stability Run at 500v Eo(50 mv per hour)				
38. Final Cal. Eo at 500v & Ov HOT				
39. Final Cal. Milliammeter Shunt HOT (2%)				
40. Spray PCB's & Button Up				

(tolerances)
1/t - less than
105/130 - from 105 to 130 volts line

NO.	CHANGES	SER



ALL RESISTORS 10% TOL COMP. UNLESS OTHERWISE SPECIFIED.

ALL CAPACITORS IN MFD.

FACTORY SELECTED FOR 1/4% TOL.

CHANGE R28 TO 470K.

SCALE POSITION	VOLTS D.C. ACROSS C.B.C.D AT
0,1	280
2,3	410
4,5	520
6	600
7	660
8	720
9	780
10	840

WHILE VOLTAGES ARE SHOWN TO PRECISE VALUES, THESE MAY VARY BY SEVERAL VOLTS BETWEEN UNITS, PARTICULARLY PLATE VOLTAGES. GRID-CATHODE POTENTIAL DIFFERENCES OF V4 THRU V7 SHOULD VARY BY LESS THAN 1 VOLT FROM VALUES SHOWN HERE HOWEVER.

ALL VOLTAGES MEASURED WITH RESPECT TO THIS BUS USING FLUKE MODEL 800 OR 801 DIFFERENTIAL DC VOLTMETER.

TEST CONDITIONS:
LINE VOLTAGE: 117 V.
OUTPUT VOLTAGE: 1 0V
OUTPUT CURRENT: 0 MA

MODEL 407R
SER. NO. 980 AND ABOVE

MODEL 407
SER. NO. 1049 AND ABOVE

CIRCUIT DIAGRAM

MODEL 407	DWG. 407-3
DATE 9/6/57	DRAWN BY VH
CHECKED BY KWH	

JOHN FLUKE MFG. CO., INC.
SEATTLE, WASH.

FLUKE

TECHNICAL DATA

408A POWER SUPPLY

MODEL 408A DIRECT CURRENT POWER SUPPLY

FEATURES

- 500 to 6010 V, 0 to 20 MA
- Selective Polarity
- 0.01% Regulation
- 0.005% Stability
- 10 Millivolt Resolution
- 0.25% Calibration Accuracy
- Center Zero Panel Meter

APPLICATIONS

Calibration of:

1) High Voltage Standards
2) Electrostatic Voltmeters

Providing power for:

1) Photomultiplier Tubes
2) Proportional Counters
3) Ionization Chambers
4) Traveling Wave Tubes

DESCRIPTION

Extremely stable and well regulated, the ® Model 408A High Voltage Power Supply provides noise free DC voltages from 500 to 6010 volts. The 0 - 20 milliampere current rating allows simultaneous operation of several photomultiplier tubes from this one source. The dial readout indicates the voltage output to an accuracy better than 0.25%.

A 1.02 volt sample is available at front panel binding posts for potentiometric monitoring. This unit has a voltage resolution of 10 millivolts at any output voltage and the voltage resettability is better than 0.1%.

Separate power and high voltage switches are provided and fused separately. An automatic 30 second time delay is energized upon turn-on to allow proper warmup of components before the high voltage is applied.

The Model 408A employs precision 0.1% wirewound sampling circuits to compare a portion of the output to an internal reference. The error signal is fed from a differential amplifier to a tetrode series passing tube to achieve an extremely stable output free from the annoying effects of line voltage and load current fluctuations. Stability in both the main and auxiliary supplies is further improved by the use of regulated heater voltages.

Generous de-rating of all components, use of glass epoxy printed circuit boards, epoxy encapsulated transformers, and silicon rectifiers further increase the reliability of this instrument. A polarity switch is incorporated on the front panel which automatically removes the input power while the polarity is being switched.

ELECTRICAL SPECIFICATIONS

INPUT VOLTAGE: 117 volts, 50 - 60 cps, single phase (220/234 volt, 50 - 60 cps model available on request).

INPUT POWER: 225 watts fully loaded, 65 watts standby.

OUTPUT VOLTAGE: 500 to 6010 volts DC.

OUTPUT CURRENT: 0 to 20 milliamperes DC.

OUTPUT POLARITY: Positive or negative with respect to chassis, selected by front panel switch.

OUTPUT CONNECTORS: Amphenol MS-3102A-18-16S, one on front panel and one on rear skirt. One mating connector, Amphenol type AN-3106A-18-16P, furnished.

MONITORING OUTPUT: 1.02 volt sample (adjustable ±2.5 MV) for potentiometric monitoring at front panel binding posts.

REGULATION vs. LINE: 0.01% maximum for ±10% change in line voltage.

REGULATION vs. LOAD: 0.01% maximum from 0 to full load.

STABILITY: 0.005% per hour, 0.03% per day, after warm-up.

RIPPLE & JITTER: Less than 5 MV RMS at any output voltage and current in either polarity.

VOLTAGE CALIBRATION:

1 - 500 volt, 4 - 1000 volt steps
9 - 100 volt steps
10 - 10 volt steps
1 - 10 volt vernier

VOLTAGE RESOLUTION: 10 millivolts at any output voltage.

CALIBRATION ACCURACY: Better than 0.25%.

RESETTABILITY: Better than 0.1%.

VOLTAGE OVERSHOOT: None, fast resetting HV time delay circuit used.

METER: 3-1/2" rectangular, 6-0-6 KV.

MECHANICAL SPECIFICATIONS

MOUNTING: Standard relay rack, panel 19" wide x 8-3/4" high. Chassis dimensions 17" wide x approximately 14" deep x 8-1/4" high. Equipped with resilient feet for bench use.

WEIGHT: 46 pounds.

FINISH: Smooth gray, baked enamel. Panel machine engraved.

PRICE: $695.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U. S. A.

Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

408A TEST PROCEDURE

WARNING--HIGH VOLTAGE

The voltages available in the supply are of lethal magnitude. Extreme care should be taken in using the output of the supply and in servicing and inspecting it as contact with high voltage conductors could prove fatal. Operating in the plus polarity mode, the plate of the 4-65A regulator tube may be as much as 8 kv above ground. In the minus polarity mode, the negative side of the supply, commonly thought of as "ground", may be as much as 6 kv below ground.

I. VISUAL INSPECTION

This inspection must be performed before power is applied to the instrument. Extreme care must be used in inspecting every solder joint. One cold solder joint or loose connection can cause the loss of several days work or result in failure in service.

1. Check values of fuses against printing on front panel, check printing for quality. Check for scratches, check handles and screws for tightness and mutilation. Check knobs for tightness and alignment.

2. Check all solder and mechanical joints. Look for proper dress of of harness and resistors. Check plate caps of V1 and V2 for tightness. Check C3 on P. C. B. at both ends for tightness. Check X-1000 switch spacer for tightness.

3. Inspect diode board and be sure tubes are in proper sockets.

II OHMMETER

4.	Chassis ground to common buss-positive mode	0 ohm
	Chassis ground to common buss-negative mode	0. 5-6 meg
	Chassis ground to positive C4 - negative mode	0 ohm
	Chassis ground to positive C4 - positive mode	0. 5-6 meg
	Chassis ground to center pin to output connectors on front and rear panels - positive mode	0. 5-6 meg
	Chassis ground to center pin to output connectors on front and rear panels - negative mode	0. 5-6 meg
5.	Common buss to positive C8 and C9	Near infinity
	Common buss to B+	1 meg
	Common buss to positive C1 and C2	Near infinity

Disengage polarity switch -	
Common buss to positive C4	Near infinity
Engage polarity switch in positive polarity	
Check continuity from pin 3 V1 to positive C3	0 ohm
Set ohmmeter on X1 scale and check filament leads	
of V1, pin 3 must be center tap of filaments	0.2 ohm
Pins 1 and 7	
Negative of C3 to common buss	500 k

III OPERATION LOW VOLTAGE

Before proceeding and further check the operation of the emergency foot switch, and if it is proven OK, continue by connecting a wattmeter to the variac. Turn all dials to minimum and set variac to 30 V. A. C. The wattmeter should read approximately 5 watts and V11 will fire, also filaments of V1 will start to glow. Then increase voltage input in gradual steps and note wattage as follows:

50 V. A. C.	10 watts
70 V. A. C.	V12 fires
90 V. A. C.	35 watts + 0G3's fire
118 V. A. C.	60 watts
130 V. A. C.	70 watts

6. Remove V1 from socket leaving plate cap attached. Connect VTVM common to Pin 3 V1 socket DC probe to Pin 2 V1 socket read 108 Volts. Vary line from 130 to less than 90 Volts. Voltage should remain stable to less than 90 Volts. Trouble here is usually 0B2 V10. Replace V1 and close clamp.

7. Connect AC VTVM across R4 (20 ohm, 5 watt) on top side of P. C. B. Read approximately 6.3 V. A. C. Vary line from 105 - 130, voltage should not vary more than 0.9 Volts. Trouble here is usually V9 a 9-7 Ballast Tube.

8. Connect Heath Kit VTVM across C9 and read between 790 - 870 volts.

9. Connect an 801 to a 2:1 divider output. Connect divider input across C12 and read approximately 253 Volts at 117 V line.

10. With same setup as step 9 vary line 130 - 105 V. A. C. null the 801 in the 0.1 null range and the reading should not change more than 250 millivolts.

11. Now connect a blocking condenser across C12 and read the ripple at 130 - 105 Volts and the limit is 8 millivolts.

12. With the same setup as step 11 decrease line voltage until a sharp increase in ripple is noticed which will indicate loss of control. Must be less than 95 Volts.

13. Null an 801 between Pin 7 of V5 and common buss on the 0.01 null range. Read approximately 250 V.

14. Connect 801 same as step 13 only vary the one 130 - 105 V regulation must be better than 10 millivolts. Trouble here is usually caused by an 0G3 tube drifting.

IV. OPERATION HIGH VOLTAGE

15. Disable time delay board via a jumper and use a 12:1 divider set X1000 switch to 500 V position and line voltage at 50 V. A. C. Turn X1000 switch clockwise and look for increased output except between 500 V and 1000 V where transformer ratio is the same. Turn set off and remove jumper.

16. 408A positive polarity 0.5 kv
Load box set at 0.5 kv
AC VTVM on 0.01 V range
Line Voltage at 117 V

Adjust output of 408A to 500.00 Volts with 801 as close as possible by means of P1.

WARNING: Only a NON-METALIC SCREWDRIVER may be used and then only in the positive polarity. This pot can be as much as 6000 Volts below chassis potential !!!!!

Null 801 now on 0.1 Volt range and vary line 103 - 105 V. The output must change less than 0.01% or 50 mv.

17. Highest ripple read at the output between 130 - 105 V must be less than 5 millivolts RMS.

18. With highest ripple obtainable in step 17, repeat and then apply 20 ma load and then note ripple which must still be less than 5 millivolts.

19. Turn line voltage back to 117 V then apply 20 ma load and observe regulation of output. Must be less than 0.01%. Also ripple must be less than 5 millivolts.

20. Repeat step 16 in negative polarity except do not adjust P1.

21. Repeat step 17 in negative polarity.

22. Repeat step 18 in negative polarity.

23. Repeat step 19 in negative polarity.

24. 408A negative polarity 6 kv.
Load box set at 6 kv.
AC VTVM on 0.01 V range
Read line regulation

25. Repeat step 17 in negative polarity at 6 kv.

26. Repeat step 18 in negative polarity at 6 kv.

27. Repeat step 19 in negative polarity at 6 kv.

28. 6 kv line minimum + Load - apply load to 408A and decrease line voltage slowly until a sudden rise in ripple is noticed which indicates loss of control - write this line voltage down. Must be below 100 V line.

29. Same as step 24 in positive polarity at 6 kv.

30. Repeat step 17 in positive polarity at 6 kv.

31. Repeat step 18 in positive polarity at 6 kv.

32. Repeat step 19 in positive polarity at 6 kv.

33. Same as step 28.

V. LINEARITY SEE CHART

V1. TURN OFF HIGH VOLTAGE

Adjust meter zero on front of meter. Turn on high voltage and check meter reading as 408A is dialed up to max must be within 3% of full scale reading. Repeat in other polarity. If trouble is encountered here replace one of the 5 meg meter divider resistors with appropriate value.

VII. TIMING

34. Turn line voltage to 100 V and turn off power switch and wait about five minutes then turn power switch on and time to the second the time for a click to be heard. The maximum time for this is 90 seconds.

35. Turn power switch off wait another five minutes and repeat above at 130 Volts line. The minimum time is 15 seconds.

VIII. COVER IN PLACE

Connect a 12:1 divider
Dial 59100 Volts
Read three hours in positive polarity
Maximum allowable drift is 25 millivolts as read on 801 0.005% of 6 kv = 0.3 Volts - 12: = 0.025 Volts
Repeat in negative polarity.

IX. TECHNICIANS NAME PERFORMING ABOVE TESTS

X. DATE TEST COMPLETED

XI. TYPE OF CONNECTORS SHIPPED WITH UNIT

408A CHART

LINEARITY

OUTPUT	VERNIER	ACTUAL	2:1 DIVIDER
500	0	500	250.00
510	FULL CW	509.50 510.50	254.75 255.25

OUTPUT	X10	ACTUAL	2:1 DIVIDER
500	0	500	250.00
510	1	509.95 510.05	254.975 255.025
520	2	519.90 520.10	259.950 260.050
530	3	529.85 530.15	264.925 265.075
540	4	539.80 540.20	269.900 270.100
550	5	549.75 550.25	274.875 275.125
560	6	559.70 560.30	279.850 280.150
570	7	569.65 570.35	284.825 285.175
580	8	579.60 580.40	289.800 290.200
590	9	589.55 590.45	294.775 295.225
600	10	599.50 600.50	299.750 300.250

OUTPUT	X100	ACTUAL	10:1 DIVIDER
500	0	500	50.00
600	1	599.90 600.10	59.99 60.01
700	2	699.80 700.20	69.980 70.02
800	3	799.70 800.30	79.99 80.03
900	4	899.60 900.40	89.96 90.04
1000	5	999.50 1000.50	99.95 100.05
1100	6	1099.40 1100.60	109.94 110.06
1200	7	1199.30 1200.70	119.93 120.07
1300	8	1299.20 1300.80	129.92 130.08
1400	9	1399.10 1400.90	139.91 140.09

OUTPUT	X1000	ACTUAL	10:1 DIVIDER
500	0	500	50.00
1000	1	999.50 1000.50	99.95 100.5
2000	2	1998.50 2001.50	199.85 200.15
3000	3	2997.50 3002.50	299.75 300.25
4000	4	3996.50 4003.50	399.65 400.35
5000	5	4995.50 5004.50	499.55 500.45

408A TEST RECORD

Serial Number			Tolerance
I.	Visual Inspection		
	1. Hardware - engraving		
	2. Soldering - wiring - mounting		
	3. Tube - meters - modifications		
II.	Ohmmeter		
	4. Polarity check		
	5. Resistance check		
III.	Operation low volt		
	6. VI Screen E regulation	108V	l/t 90V
	7. V3-V5 Filament regulation		l/t 1.0V a-c
	8. Ebb 117V line		740-820
	9. Eo Aux.	117V	495-515
	10. Reg. Aux.	105-130V	.500V
	11. eo Aux.	117V	.011V
	12. e line min. Aux.		l/t 100V
	13. E reference	117V	approx. 250V
	14. E reference reg.	105-130V	l/t .010V
IV.	High Voltage		
	15. Plate Transformer check		
	16. .5 kv + line reg.	105-130V	.01%
	17. Ripple .5 kv +	105-130V	l/t 5 mv
	18. .5 kv + load reg.	117V	20 ma, .01%
	19. Ripple .5 kv +	20 ma,105-130V	l/t 5 mv
	20. .5 kv - line reg.	105-130V	.01%
	21. Ripple .5 kv-	105-130V	l/t 5 mv
	22. .5 kv - load reg.	117V	20 ma, .01%
	23. Ripple .5 kv-	20 ma,105-130V	l/t 5 mv
	24. 6 kv + line reg.	105-130V	.01%
	25. Ripple 6 kv +	105-130V	l/t 5 mv
	26. 6 kv + load reg.	117V	20 ma, .01%
	27. Ripple 6 kv +	20 ma,105-130V	l/t 5 mv
	28. 6 kv + line min.	20 ma	l/t 100V
	29. 6 kv - line reg.	105-130V	.01%
	30. Ripple 6 kv -	105-130V	l/t 5 mv
	31. 6 kv - load reg.	117V	20 ma, .01%
	32. Ripple 6 kv -	20 ma,105-130V	l/t 5 mv
	33. 6 kv - line min.	20 ma	l/t 100V
V.	Linearity .5 kv to 6 kv		See Chart
VI.	Meter Accuracy		2%
VII.	Timing		
	34. Time delay 100V line		l/t 1 min.
	35. Time delay 130V line		m/t 20 sec.
VIII.	Stability, Minimum 3 hours in each polarity		
	36. Per hour		.005%
	37. Per day		.05%

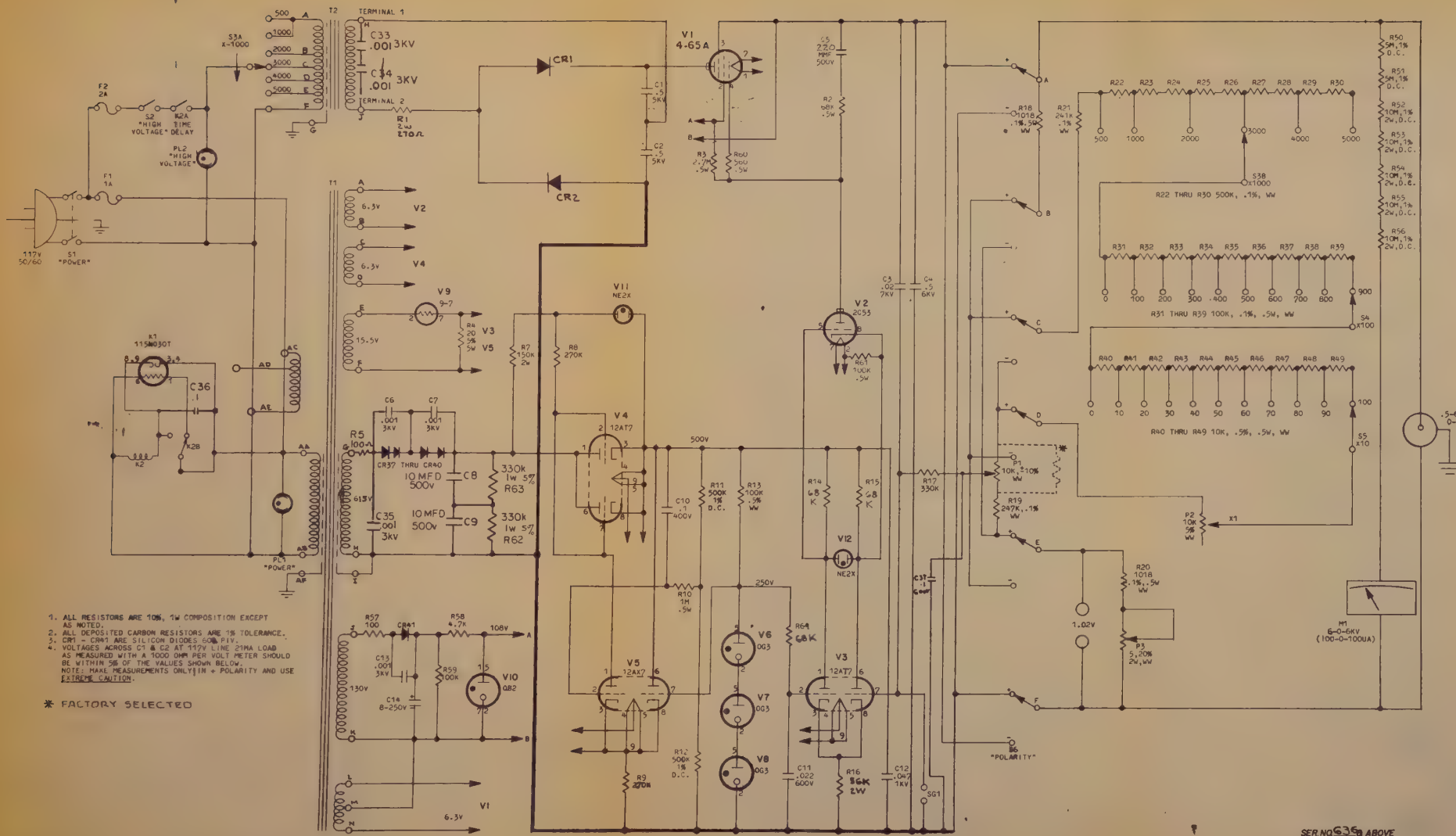
(Tolerance)

l/t----------less than
m/t---------more than

Time	+Reading	Time	-Reading

Test Technician

Date



X-1000 SW SETTING	900	1000	2000	3000	4000	5000	
D.C. VOLTAGE	2880	2880	4140	5340	6520	7750	

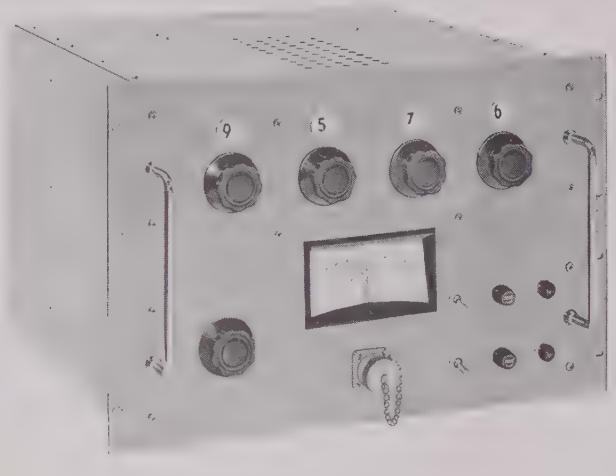
SER. NO 635 & ABOVE

MODEL 408A D.C. POWER SUPPLY
JOHN FLUKE MFG. CO., INC.
SEATTLE, WASH

FLUKE

TECHNICAL DATA

410A POWER SUPPLY



FEATURES

1000 to 10,010 V, 0 - 10 MA
Selective Polarity
0.01% Regulation
0.005% Stability
10 Millivolt resolution
Calibration Accuracy better than 0.25%
Four-dial, Direct in-line Readout
Center Zero Panel Meter
Safety Engineered with Voltage Interlocks

APPLICATIONS

Providing power for:
1) Backward Wave Oscillator Tubes
2) Traveling Wave Tubes
3) Photomultiplier Tubes
4) Klystrons
5) Ionization Chambers

Calibration of:
1) High Voltage Standards
2) Electrostatic Voltmeters

DESCRIPTION

The ℱ Model 410A High Voltage Power Supply provides highly regulated, stable, noise free DC voltages from 1 to 10 KV. The wide voltage and current range, extremely low ripple, and high resolution make this instrument a valuable aid to nuclear research. The in-line dial readout indicates the voltage output to an accuracy better than 0.25%.

Separate power and high voltage switches are provided and are fused separately. An automatic 30 second time delay is energized upon turn-on to allow proper warmup of components before the high voltage is applied. One of the many safety features incorporated in this unit is a high voltage interlock which requires that the output be turned down to less than 3000 volts before the high voltage can be activated. This prevents accidental damage to auxiliary equipment.

The Model 410A employs precision 0.1% wirewound sampling circuits to compare a portion of the output to an internal reference. The error signal is fed from a differential amplifier to a tetrode series passing tube to achieve an extremely stable output free from the annoying effects of line voltage and load current fluctuations. Stability in both the main and auxiliary supplies is further improved by the use of regulated heater voltages.

Generous de-rating of all components, use of glass epoxy printed circuit boards, hermetically sealed transformers and silicon rectifiers further increase the reliability of this instrument. A unique polarity switch is incorporated on the front panel which automatically removes the input power while the polarity is being switched.

The instrument is designed for bench use as well as rack mounting, and is provided with hardwood skids for ease of movement.

ELECTRICAL SPECIFICATIONS

INPUT VOLTAGE: 117 volts, 50 - 60 cps, single phase.

INPUT POWER: 250 watts fully loaded, 60 watts standby.

OUTPUT VOLTAGE: 1.00 KV to 10.01 KV direct current.

OUTPUT CURRENT: 0 - 20 MA to 6 KV. 0 - 10 MA to 10.01 KV.

OUTPUT POLARITY: Positive or negative with respect to chassis, selected via front panel switch.

OUTPUT CONNECTOR: Amphenol MS-3102A-18-16S, one on front panel and one on rear skirt with protective caps. One mating connector, Amphenol type AN-3106A-18-16P furnished.

REGULATION vs. LINE: 0.01% maximum for ±10% change in line voltage.

REGULATION vs. LOAD: 0.01% maximum from 0 to full load.

STABILITY: 0.005% per hour maximum after warmup. 0.05% per day maximum after warmup.

RIPPLE: Less than 5 MV RMS at any output voltage and current in either polarity.

VOLTAGE CALIBRATION:

9 - 1000 volt steps
9 - 100 volt steps
10 - 10 volt steps
1 - 10 volt vernier

METERED OUTPUT: Center zero 10 KV meter.

VOLTAGE RESOLUTION: 10 millivolts at any output voltage.

CALIBRATION ACCURACY: Better than 0.25%.

MECHANICAL SPECIFICATIONS

MOUNTING: Standard relay rack. Panel 19" wide x 12-7/32" high. Chassis dimensions 17" wide x 17" deep x 11-3/4" high. Equipped with hardwood skids.

WEIGHT: 95 pounds.

FINISH: Smooth gray baked enamel - panel machine engraved.

PRICE: $1095.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U. S. A.

Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

MODEL 410A TEST PROCEDURE

An orderly test procedure will insure that no phase of the inspection is overlooked as well as reducing the test time needed.

I. Visual Inspection

This inspection must be performed before power is applied to the instrument.

A. Mechanical checks

1. Check the front panel for flaws and engraving errors.
2. Check the polarity switch knob for alignment with the engraving.
3. Make sure that all of the knobs are tight.
4. Check that all screws are tight, especially those on the output connectors and the transformers.

B. Electrical checks

1. Amplifier P.C.B. pre-check

   a. Check all solder joints.
   b. The pot P2 should be firmly mounted to the board.
   c. The high voltage capacitor C3 should be checked for firm mounting and a tight electrical connection.
   d. Check the board for clearance between components. No component should be touching another.
   e. Check that the neons are not broken or shorted.
   f. Make certain that the board contains all modifications.

2. Assembled instrument check

   a. Check all solder joints. All joints must be smooth hot-solder joints with no lead tips protruding. This is absolutely necessary for low corona.
   b. The ground lugs of the two output connectors must be bussed and well soldered.
   c. The high voltage switch and the polarity switch must have no lead ends protruding through the solder and no sharp points on solder connections.
   d. The polarity switch rotor leads must have enough slack so they do not pull tight in either mode.
   e. Plate cap leads should be positioned to avoid both the chassis and other components. Check them for firm fitting and lead lengths to allow removal of plate caps.
   f. Check the seating of all tubes.
   g. Check the mounting of all sub-chassis.
   h. Check the instrument for the latest modifications.

II. Ohmmeter Checks

A. Amplifier P.C.B. pre-check

1. Common bus to positive C6 and C7 - near infinity
2. Common bus to B+, 1 megohm

B. Assembled Instrument check

1. Common bus to positive C1 and C2 - near infinity
2. Disengage polarity switch
   a. Common bus to positive C4 - near infinity
   b. Common bus to positive C3 - near infinity
   c. Engage polarity switch - positive mode
3. Chassis ground to common bus - positive mode - 0Ω
4. Chassis ground to common bus - negative mode - 1 to 10 megohms
5. Chassis ground to positive C4 - negative mode - 0Ω
6. Chassis ground to positive C4 - positive mode - 1 to 10 megohms
7. Chassis ground to center pin of output connector front panel - positive mode - 1 to 10 megohms
8. Chassis ground to center pin of output connector - front panel - negative mode - 1 to 10 megohms
9. Repeat (8) for rear panel connector - 1 to 10 megohms
10. Repeat (7) for rear panel connector - 1 to 10 megohms
11. Disengage polarity switch. Center pin of output connector to chassis - 100 megohms
12. Set a VTVM to X-1 scale and check the filament leads of the series passing tube board. The yellow lead must be the center tap of the two brown leads. (0.2Ω)
13. Check continuity from the yellow lead to the top of C3.

III. Operation Check

Be certain that all power switches are turned off and output connector caps are in place; "POL" switch in positive position.

A. Low Voltage

1. Preliminary

   a. Adjust line to 117 V
   b. Set VTVM to DC+, 1500 V range
   c. Plug in line cord

2. Amplifier P.C.B. pre-check - VTVM 1500V range, E line = 117 V

   a. Turn on power switch and observe filaments and 2 neons. If the 2 neons are not lit, check the respective circuits.
   b. Read the voltage across C7, 790 to 870 V. Test point #1.
   c. Apply 500 V to 10:1 divider input.
   d. Place ripple meter in parallel and set on 0.01 range.

e. With an 801 across the divider output, read the auxiliary supply voltage. Test point #2.
   (1) If within 495-515 V, do auxiliary regulation.
   (2) Lack of proper regulation in the auxiliary supply may be due to faulty OG3's, 12AT7, R9, C8, C9, R7 or R8.

f. Auxiliary regulation
   (1) The aux supply should regulate to within a total deviation of 0.240 V or 24 mv on 801 with a 10:1 divider for a line change down to 105 V and up to 130 V. Select a 12AX7, V5, which will accomplish this.
   (2) Record the ripple reading across the auxiliary supply with the line at 117 V. It must be less than 8 mv.
   (3) If these two limits cannot be met, there is trouble in the circuit which must be found.
   (4) Decrease the line voltage, if the auxiliary supply is regulating, to where the ripple meter indicates a sudden rise (loss of control). This point must be below 95 V line.

g. Place an 801 across the reference supply and record the reading (about 250 V) with a total deviation of 10 mv maximum for a line change from 105 to 130 V. Test point #3.

h. Remove the PL177A tube and check the voltage from the top of C3 to pin 2 of the PL177A. This should read 108 V.

i. Check to see that the screen grid supply regulates to below 95 V line.

3. Assembled instrument check

   a. Repeat steps III, A, 2, a thru i.

IV. High Voltage

CAUTION: The 410A is rated 0 to 10 ma, 1 kv to 10.01 kv. This power range IS SUFFICIENT TO KILL. BE EXTREMELY CAREFUL.

A. High Voltage Preparation

1. Place a 20 kv voltage divider box across the output of the supply. The positive lead connects to the 10 kv terminal.
2. Place an 801 across the divider output (500 V).
3. Place a 20 kv blocking capacitor across the 10 kv and common terminals, with a ripple meter across the output of the blocking capacitor.
4. Connect the common terminal of a 10 kv, 10 ma load box to the common terminal of the voltage divider box.
5. Set an 801 on the VTVM range.
6. Set the ripple meter to 0.01 range.

B. Plate Transformer Check

1. Place a clip lead from the brown wire on the time delay board to the green wires on the same board. These points are the turret lugs used as input tie points to the board.

2. Place a clip lead (30 kv wire) from the PL177A plate cap to the 10 kv input of a voltage divider box.
3. With the 410A dialed to 1 kv output in POSITIVE polarity,
4. Set the variac to zero and turn it on.
5. Increase the variac to about 10 V line, or until a reading is barely visible on the 801 VTVM range.
6. Dial the 410A from 1 to 9 kv output checking to see that the unregulated supply increases with each step of the X-1000 switch.

   If this result is NOT obtained, the plate transformer primary has been wired incorrectly.
7. REMOVE THE CLIP LEAD.

C. 1 KV Output

1. Positive polarity, output to 10 kv divider, PL177A plate cap replaced.
   a. Set all knobs to minimum.
   b. Set variac to 117 V.
   c. Turn on "POWER".
   d. Wait about 20 seconds for the time delay circuit to close.
   e. Make certain the "POLARITY" switch is pushed in as far as it will go.
   f. Turn on the "HIGH VOLTAGE".
   g. Adjust P2 for a null reading of 50 V on the 801.
      NOTE: The access hole for P2 is located on the right side of the instrument. WARNING: Only a non-metallic screwdriver may be used and then ONLY IN THE POSITIVE POLARITY. This pot can be as much as 10,000 volts below chassis potential.
   h. Vary the line voltage from 105 to 130 volts. (5 mv total deviation.) A difficulty in accomplishing this may be due to a faulty V3. Select a 12AX7 to give this tolerance.
   i. Record the maximum ripple seen for this change. (Less than 5 mv.)
   j. With the line voltage set at 117 V, apply a 10 ma load at 1 kv. The output must not vary more than 5 mv on the 801. A difficulty in meeting this indicates changing V2, 6BK4.
   k. Record the maximum ripple seen for this change. (Less than 5 mv.)
2. Negative Polarity
   a. TURN OFF THE SUPPLY.
   b. Reverse polarity.
   c. Reverse the 801 input and cast loose the ground bus on the 801.
   d. Repeat step 1 in negative polarity. DO NOT ADJUST P2.

D. 10 KV Output. Shut off the high voltage.

1. Set 410A polarity to "POS" with an appropriate polarity on the 801.
   a. Turn on the supply and dial it to 10 kv. SIEZE THE CAPACITORS by dialing the X-100 dial to 9, back to 0, and then step the X-1000 one step. Again dial the X-100 from 0 to 9, back to zero, and step the X-1000 one more step. Do this clear to 10 kv.

b. Vary the line from 105 to 130 V. This must not exceed 50 mv on the 801.
   (1) Difficulty in meeting this indicates selection of a suitable V3. This tube must be capable of controlling the supply at maximum as well as minimum output.
c. Record the maximum ripple seen for this variation. (Less than 5 mv.)
d. With the line at 117 V, apply a 10 ma, 10 kv load.
   (1) The variation should not exceed 50 mv on the 801. If it exceeds this, the trouble may be a faulty V2, 6BK4.
   (2) If the 6BK4 is changed, recheck the line regulation.
e. Record the maximum ripple seen for this variation of load. (Less than 5 mv.)
f. Apply a 10 ma, 10 kv load, vary the line voltage from 105 to 130 V and record this. It must not exceed 50 mv on the 801.
g. Record the maximum ripple seen for this change. It must be less than 5 mv.
h. With a 10 ma load applied, reduce the line voltage until a sudden rise appears on the ripple meter. This signifies a loss of regulation. This point must be below 100 V. Record this voltage.

2. Negative Polarity
   a. TURN OFF the supply and set it to NEGATIVE polarity.
   b. Reverse the 801 input.
   c. With the supply in the negative mode, turn on the high voltage and dial it to 10 kv.

      WARNING: DO NOT ADJUST P2.

   d. Repeat steps IV, D, 1, b thru h.

E. Minimum Line, Maximum Load

1. Negative Polarity
   a. Dial the supply down to 1 kv.
   b. Apply a 10 ma, 1 kv load.
   c. Decrease the line gradually until a sudden rise appears on the ripple meter. This signifies a loss of regulation. This point must be below 100 V. Record this voltage.
      (1) Difficulty in obtaining the proper line minimum may be due to any tube in the supply. Tube V2, 6BK4 is the most probable source of trouble.

2. Positive Polarity
   a. Shut off the supply.
   b. Reverse the 410A polarity and the 801 input.
   c. Repeat steps IV, E, 1, b and c.

V. Linearity

A. Preparation

1. Set an 801 in positive mode.
2. Connect the 410A output to the 5 kv input of the divider box.
3. Start the 410A and set to 1 kv.
4. Dial the 801 to 100.00 volts and null to within 1 mv using P2.

B. X-1 Pot

1. Set the 801 to the 0.1 volt scale and rotate the X-1 pot on the 410A. Make certain the pot gives a 1 volt deviation on the 801 using a 10:1 divider. Also make certain the pot is not wired in backwards.

C. X-10

1. Step the X-10 switch from 0-10 seeing that no resistor registers more than a 5 mv change on the 801.

The readings should be:

Output	X - 10	Actual	801 (10:1 Divider)
1000	0	1000	100.0
1010	1	1009.95 - 1010.05	100.995 - 101.005
1020	2	1019.90 - 1020.10	101.990 - 102.010
1030	3	1029.85 - 1030.15	102.985 - 103.015
1040	4	1039.80 - 1040.20	103.980 - 104.020
1050	5	1049.75 - 1050.25	104.975 - 105.025
1060	6	1059.70 - 1060.30	105.970 - 106.030
1070	7	1069.65 - 1070.35	106.965 - 107.035
1080	8	1079.60 - 1080.40	107.960 - 108.040
1090	9	1089.55 - 1090.45	108.955 - 109.045
1100	10	1099.50 - 1100.50	109.950 - 110.050

D. X-100

1. Dial the 410A to 1 kv output and again null the 801 to 100.00 volts within 1 mv by adjusting P2.
2. Step the X-100 switch from 0 to 9 seeing that no resistor registers more than a 10 mv change on the 801.

Output	X-100	Actual	801 (10:1 Divider)
1000	0	1000	100.0
1100	1	1099.9 - 1100.1	99.99 - 110.01
1200	2	1199.8 - 1200.2	119.98 - 120.02
1300	3	1299.7 - 1300.3	129.97 - 130.03
1400	4	1399.6 - 1400.4	139.96 - 140.04
1500	5	1499.5 - 1500.5	149.95 - 150.05
1600	6	1599.4 - 1600.6	159.94 - 160.06
1700	7	1699.3 - 1700.7	169.93 - 170.07
1800	8	1799.2 - 1800.8	179.92 - 180.08
1900	9	1899.1 - 1900.9	189.91 - 190.09

E. X-1000

1. Shut off the supply.
2. Connect the output to 10 kv divider input.
3. Start the supply IN THE POSITIVE POLARITY and dial it to 5 kv.
4. Null the 801 and calibrate the output by adjusting P2 to within 1 mv of 250 V on the 801.
5. Step the X-1000 switch from 1 to 9 seeing that no resistor registers more than a 50 mv change on the 801.

Output	X-1000	Actual	801 (20:1 Divider)
1000	1	999 - 1001	49.95 - 50.05
2000	2	1998 - 2002	99.90 - 100.10
3000	3	2997 - 3003	149.85 - 150.15
4000	4	3996 - 4004	199.80 - 200.20
5000	5	4995 - 5005	249.75 - 250.25
6000	6	5994 - 6006	299.70 - 300.30
7000	7	6993 - 7007	349.65 - 350.35
8000	8	7992 - 8008	399.60 - 400.40
9000	9	8991 - 9009	449.55 - 450.45

VI. Meter Accuracy

A. Calibrate

1. The supply MUST be in the POSITIVE POLARITY.
2. Set the line to 117 V.
3. Zero the 410A meter with the supply off.
4. Turn on the supply and set to 10 kv.
5. Null the 801 to within 0.1 V using P2 on the right side of the instrument.
6. Set the meter to 10 kv using P4. P4 is mounted on the meter resistor board and is accessible through the front access hole beneath the amplifier P.C.B. Use a NON-METALLIC screwdriver.

7. Dial the supply down to 1 kv and check for an error of less than 2% (20 V).
8. Shut off the supply.
9. Place the supply in negative polarity and check the meter calibration. DO NOT ADJUST P4 WITH THE SUPPLY IN THE NEGATIVE POLARITY .

VII. Timing

There must be a delay between the time the low voltage is applied and the time high voltage can be demanded of the supply.

A. Adjust the line to 100 V.
B. Turn on both power and H.V.
C. Time in seconds CK1 delay (about 18 seconds).
D. Pot P3 is located on the time delay board. This pot varies the time duration of the delay circuit.
E. Turn off supply and adjust line to 130 V.
F. Turn on both power and H.V.
G. Time in seconds CK1 delay (about 23 seconds).

VIII. Stability

This instrument should now produce 10 kv with a stability of less than 500 mv change per hour.

A. Preparation

1. Install forward chassis cover.

B. Stability test

1. With the output set to 10 kv within 1 mv, allow the instrument to run undisturbed for one hour.
2. After one hour recheck the output with a stable and closely adjusted 801 through a 20 to 1 divider box. There should be less than 25 mv change in this reading.
3. After the first hour the reading may exceed 25 mv change.
4. After the second hour the reading should change less than an additional 25 mv, i.e.: less than 500 mv total.
5. Read the output 3 consecutive hours in the positive polarity.
6. Read the output 3 consecutive hours in the negative polarity.

IX. Shipment

When the instrument meets all previously listed specifications, it may be closed up and sent to shipping.

410A TEST RECORD

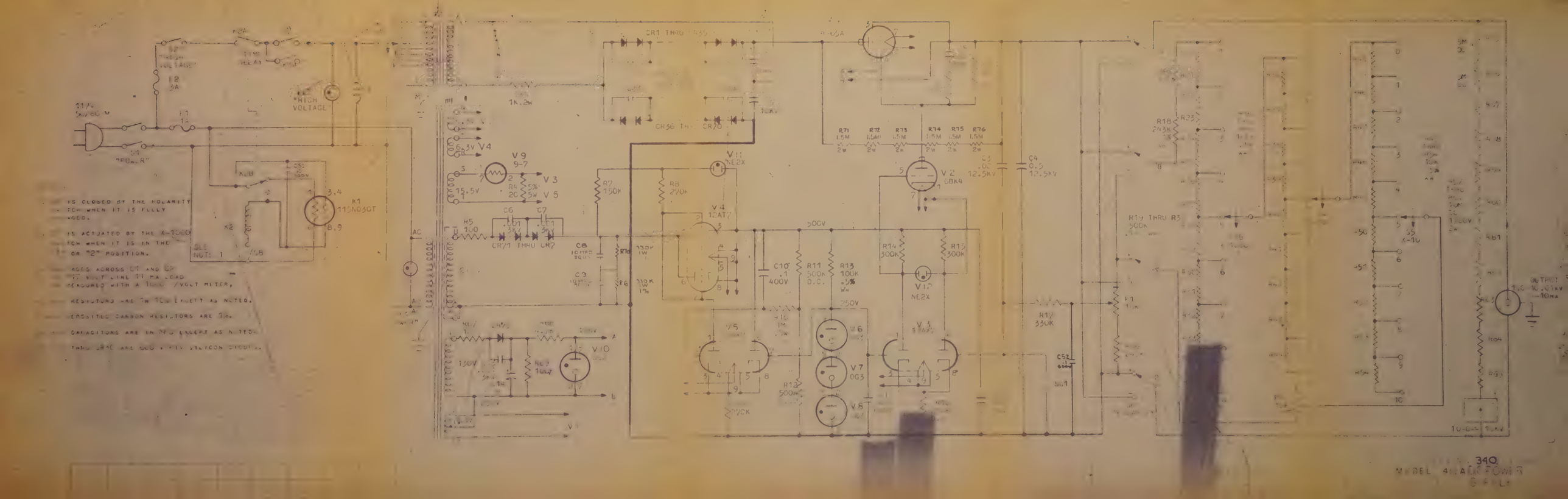
Serial Number:		Tolerance	
I. Visual Inspection			
1. Hardware - engraving			
2. Soldering - wiring - mounting			
3. Tube - meters - modifications			
II. Ohmmeter			
4. Polarity check			
5. Resistance check			
III. Operation low volt			
6. V1 Screen E regulation	108V	1/t 90V	
7. V3-V5 Filament regulation		1/t .9V a-c	
8. Ebb 117V line		790-870	
9. Eo Aux.	117V	495-515	
10. Reg. Aux.	105-130V	.240V	
11. eo Aux.	117V	.008V	
12. e line min. Aux.		1/t 95V	
13. E reference	117V	approx. 250V	
14. E reference reg.	105-130V	1/t .010V	
IV. High Voltage			
15. Plate Transformer check			
16. 1 kv + line reg.	105-130V	.01%	
17. Ripple 1 kv +	105-130V	1/t 5 mv	
18. 1 kv + load reg.	117V	10 ma, .01%	
19. Ripple 1 kv +	10 ma, 105-130V	1/t 5 mv	
20. 1 kv - line reg.	105-130V	.01%	
21. Ripple 1 kv -	105-130V	1/t 5 mv	
22. 1 kv - load reg.	117V	10 ma, .01%	
23. Ripple 1 kv -	10 ma, 105-130V	1/t 5 mv	
24. 10 kv + line reg.	105-130V	.01%	
25. Ripple 10 kv +	105-130V	1/t 5 mv	
26. 10 kv + load reg.	117V	10 ma, .01%	
27. Ripple 10 kv +	10 ma, 105-130V	1/t 5 mv	
28. 10 kv + line min.	10 ma	1/t 100V	
29. 10 kv - line reg.	105-130V	.01%	
30. Ripple 10 kv -	105-130V	1/t 5 mv	
31. 10 kv - load reg.	117V	10 ma, .01%	
32. Ripple 10 kv -	10 ma, 105-130V	1/t 5 mv	
33. 10 kv - line min.	10 ma	1/t 100V	
V. Linearity 1 kv to 10 kv		See Chart	
VI. Meter Accuracy		2%	
VII. Timing			
34. Time delay 100V line		1/t 30 sec.	
35. Time delay 130V line		m/t 18 sec.	
VIII. Stability, Minimum 3 hours in each polarity			
36. Per hour		.005%	
37. Per day		.05%	

(Tolerances)
1/t -------less than
m/t-------more than

Time	+ Reading	Time	- Reading

Test Technician

Date


IS CLOSED BY THE POLARITY
TCH WHEN IT IS FULLY
GED.
IS ACTUATED BY THE X-1000
TCH WHEN IT IS IN THE
OR "2" POSITION.
AGES ACROSS C1 AND C2
17 VOLT LINE 11 MA LOAD
EASURED WITH A 1000 Ω/VOLT METER,
RESISTORS ARE 1W 10% EXCEPT AS NOTED.
DEPOSITED CARBON RESISTORS ARE 1W.
CAPACITORS ARE IN MFD EXCEPT AS NOTED.
THRU CR6 ARE 600 V PIV SILICON DIODES.
HIGH VOLTAGE
TIME DELAY
1K 2W
CR1 THRU CR5
CR6 THRU CR10
V1 6SA
V2 6BK4
V3 6AU6
V4 12AT7
V5 6AL5
V6 6AL5
V7 0G3
V8 6AL5
V9 9-7
V10 OA2
V11 NE2X
V12 NE2X
R7 150K
R8 270K
R11 500K D.C.
R13 100K .5% 1W
R14 300K
R15 300K
R17 330K
R18 243K
R19 THRU R23 500K
C3 .05 12.5KV
C4 0.5 12.5KV
C6 .01 3KV
C7 .01 3KV
C8 10MFD 300V
C10 .1 400V
C11 .1 1KV
C12 .1 1KV
K1 115N050T
K2
K5 100
CR11 THRU CR17
300V
350V
250V
150V
105V
77VDC
OUTPUT
1.5Ω 10.25KV
-10MA
10-0-10 1.5KV
340
MODEL 4 AUDIO POWER

FLUKE

TECHNICAL DATA

412A POWER SUPPLY

FEATURES

- 500 to 2010 V, 0 - 15 ma output
- 10 mv resolution
- Only 3-1/2" high
- 0.01% regulation
- 0.005% stability

APPLICATIONS

- Direct calibration of DC Voltmeters
- Power source for -

1) Photomultiplier tubes

2) Traveling wave tubes

3) Klystrons

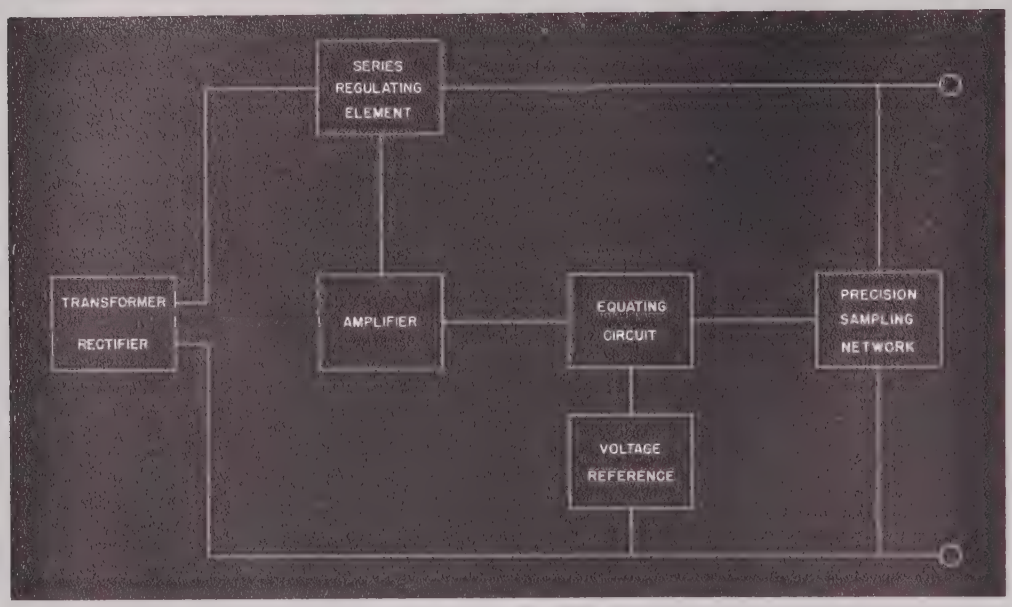
DESCRIPTION

Model 412A provides a full 15 milliamperes over a 500 to 2010 volt range in the most compact enclosure available today. The use of hermetically sealed silicon rectifiers, oil filled high temperature capacitors and generously derated transformers insure continuous, trouble free, full load operation.

Output voltage controls using precision wirewound resistors are calibrated to an accuracy of better than 0.25%. Two of the highly stable 85A2 (OG3) tubes operating at constant current provide the reference voltage. A 12AX7 differential amplifier, operating with regulated filament voltage, serves as the equating element. This combination of circuit elements provides the ultimate in regulation, calibration accuracy and stability.

The Model 412A is engineered for maximum performance in minimum space.

MODEL 412A SIMPLIFIED BLOCK DIAGRAM



ELECTRICAL SPECIFICATIONS

INPUT VOLTAGE: 117 V, 50 - 60 cps, single phase (220/234 V, 50 - 60 cps, model available on request).

OUTPUT VOLTAGE: 500 - 2010 volts.

OUTPUT CURRENT: 0 - 15 milliamperes.

REGULATION vs. LINE: 0.01% maximum for ±10% change in line voltage.

REGULATION vs. LOAD: 0.01% for full load change.

STABILITY: 0.005% per hour, 0.03% per day.

OUTPUT POLARITY: Plus or minus to chassis, selected by front panel switch.

OUTPUT CONNECTOR: Two type UG931/U, one on front panel, one on rear skirt. Supplied with one type UG932/U mating connector.

RIPPLE: Less than 5 mv RMS under all conditions, no jitter.

VOLTAGE CALIBRATION:
14 - 100 volt steps.
10 - 10 volt steps.
1 - 10 volt vernier.

ACCURACY: Better than 0.25% absolute.

METER: 3 inch with 0 - 2000 volt scale.

VOLTAGE RESETTABILITY: Better than 0.1%.

RESOLUTION: 10 mv at any output voltage by 10 volt vernier control.

OVERSHOOT: None under any conditions.

MECHANICAL SPECIFICATIONS

DIMENSIONS: 3-1/2" x 19" panel, chassis 14" deep, 17" wide.

WEIGHT: 28 pounds.

SHIPPING WEIGHT: 33 pounds.

PRICE: $455.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U.S.A.

Electronics FOR INDUSTRY

FLUKE
JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

412A LATEST TEST PROCEDURE

1. VISUAL INSPECTION:

   a. Check output connectors on front and rear panels for tightness.

   b. Check Phillips head screws and slot head screws on bottom.

   c. Check the rack handles.

   d. Check spacing of knobs on the front panel, rotate vernier to full clockwise and set on ten.

   e. Pick a systematic way of checking the rest of the assorted components.

   f. Look for correct positioning of silicon diodes; especially polarity.

   g. Look for the lug pins on P.C.B. that are not soldered to the foil.

   h. Look for missing jumpers on C9A and C9B also look for unclipped extensions of these jumpers.

2. OHM METER CHECK

   a. C1 and C2 more than 50 meg each.

   b. C3 - 100 meg.

   c. C4 0.5 - 1.7 meg depending on time 100 and times 10 switch positions.

   d. Output connector positive and negative polarities same as C4 should be infinity in the off position.

   e. C9A and C9B 500K approximately.

3. PRELIMINARY CHECK

   a. Switch instrument on and make these spot check voltages at 117 Volts line C9A 425 Volts (The unit draws 35 watts on 117 Volts line)

   b. C9B 265 Volts

   c. Extended lead of 45K R35 1/2 W.W.W. reference voltage should be 170 Volts

   d. Note -- did the 6BG6's arc when switching on high voltage?

   e. If above is okay, dial up 2000 volts in the pos. polarity and let instrument run at least 24 hours before continuing further checks.

THE STEPS 4 to 11 WILL CHECK THE FUNCTION OF AUX. AND REF. SUPPLY. IT IS NOT NECESSARY TO HAVE THE H.V. ON -- USE EXTREME CAUTION! THE INSTRUMENT IS A SELECTIVE POLARITY SUPPLY. THE NEG. BUS IS AT CHASSIS OR EARTH POTENTIAL ONLY WHEN POLARITY SWITCH IN IN + POSITION. - WITH THE POLARITY SWITCH IN - POSITION THE NEGATIVE BUS MAY BE AS MUCH AS 2000 VOLTS BELOW CHASSIS GROUND.

4. BALLAST TUBE REGULATION

Using H.P. Model 400D 10 Volt range clip across R38 20 ohm 5 watt resistor below the ballast tube vary line voltage between 100 and 130 Volts and wait one-half minute in each position, the voltage difference must be less than 0.7 Volts.

5. EBB

Ebb is measured at 117 Volts because it is unregulated E.M.F. between positive sides of C9A (Right hand section viewed from the front) and B minus or 0 Volt buss this voltage must read between 415 and 445 Volts.

6. Eo AUX

This voltage is measured at 117 Volts and is measured from positive side of C9B and 0 Volt buss read with an 801 in the 0.1 range. The voltage must be within 265 to 275 Volts.

7. REG. AUX

With the same connections as above vary the line voltage between 100 and 130 Volts and look for a variation of less than 150 millivolts. If instrument fails to regulate changing V2 12AX7 will remedy this. (80 millivolts can be obtained.)

8. eo AUX

Set line voltage at 117 Volts and read the Aux ripple voltage on the 400 D in the 10 millivolt range. This ripple must be less than 8 millivolts.

9. e LINE MIN. AUX

With the same setup as above, connect a scope to the output of the 400 D then decrease the line voltage and note where supply loses control. This must be below 95 Volts line. The loss of control is also indicated by sudden increase of the ripple meter reading.

10. E REF.

Is measured at 117 Volts line between pin 5 of V7 and the "0" volt buss is measured on the 0.1 range of a Model 801 and should read approximately 167 Volts or 170 ± 4 Volts.

11. REG. E REF.

With the same setup as above vary the line voltage between 100 and 130 volts and look for a variation of less than 3 millivolts, if more than this, change the OG3's.

THIS READING COMPLETES THE AUX. SUPPLY CHECK. USE EXTREME CAUTION WHEN WORKING WITH HIGH VOLTAGE!

12. E ACROSS C3

Using a 10 to 1 divider and with instrument at 117 Volts line, measure across C3 which should read approximately 3.2KV (3,200 Volts)

USED IN FIRST INSTRUMENTS TO CHECK SECONDARY WINDINGS FOR INCONSISTANCE.

13. 500V PLUS LINE REG.

Do this by setting P2 POT on P.C.B. to 498 Volts approximately, then this 500 Volt reading can be made direct. Vary line voltage 100 to 130 Volts allowing approximately one minute to settle down, read this on 0.1 or 1 Volt range of 801 whichever is easiest to see a 50 millivolt change direct, if more than this change V1 12AX7 and repeat till less than 50 mv regulation.

14. 500V PLUS RIPPLE

After accomplishing line regulation,hook up the 400 D and connect a scope and vary the line between 100 and 130 Volts and look for oscillations and at all times the ripple must be less than 5 millivolts. Excessive ripple may be cured by changing V11 and then starting over with Step 13.

15. 500V PLUS LOAD REG.

With line at 117 Volts apply a 15 milliampere load. The specs. allow 0.03% regulation or a change of 150 millivolts reading direct (Suggestion: don't pass anything above 0.028% because they usually fail in the 500V minus position when the load is applied.) Note also, that the ripple does not go above 5 millivolts when a load is applied. Poor load regulation is caused by V1 12AX7, start over with Step 13 (Often V1 will be good on line, poor on load or the other way around - keep selecting).

16. 500V MINUS REG. LINE

Change polarity on 412 and 801 and proceed by varying voltage 100 to 130 Volts allowing approximately one minute to settle down, read this on 0.1 or 1 Volt range of 801 whichever is easiest to see a 50 millivolt change direct, if more than this change V1 12 AX7 and start over with Step 13.

17. 500V MINUS RIPPLE

After accomplishing line regulation, hook up the 400 D and connect a scope and vary the line between 100 and 130 Volts and look for oscillations and at all times the ripple must be less than 5 millivolts. Note the negative spikes in the scope in this negative position - they are normal, also ripple will be about 0.5 millivolts higher than the 500 plus reading.

18. 500V MINUS LOAD REG.

With line at 117 Volts apply a 15 milliampere load. The specs. allow 0.03% regulation or a change of 150 millivolts reading direct. If more than this change V1 12 AX7 and start over with Step 13.

19. 2KV MINUS LINE REG.

Dial up 2,000 Volts and use a 4:1 divider (don't change polarity) and proceed as in Step 16.

20. 2KV MINUS RIPPLE

Use a blocking capacitor and hook up the 400 D connect the scope and vary the line between 100 and 130 Volts and look for oscillations and at all times the ripple must be less than 5 millivolts. (Sharp spikes shown on scope are normal in this position)

21. 2KV MINUS LOAD REG.

Set line and 117 Volts, apply a 15 milliampere load and not the regulation must be less than 0.03% or less than 150 millivolts through a 4:1 divider. Be sure ripple is less than 5 millivolts.

22. 2KV MINUS LINE MINIMUM

After line, load and ripple are recorded, reconnect 15 milliamp load and decrease line voltage till 412 looses control. Watch scope and 400 D. Must be less than 100 Volts when supply looses control.

23. 2KV PLUS LINE REG.

Change polarity of 801, a 412 and dial up 2000 Volts and use a 4:1 divider and proceed as in Step 16.

24. 2KV PLUS RIPPLE

Proceed as Step 20 except sharp spikes not noticeable.

25. 2KV PLUS LOAD

Set line and 117 Volts, apply a 15 milliampere load and note the regulation must be less than 0.03% or less than 150 millivolts through a 4:1 divider. Be sure ripple is less than 5 millivolts.

26. 2KV PLUS LINE MINIMUM

After line, load, and ripple are recorded reconnect 15 milliamp load and decrease line voltage till 412 looses control. Watch scope and 400 D. Must be less than 100 Volts.

27. LINEARITY MIN Eo TO MAX Eo AND X1 POT RANGE

28. Check X10 switch first by setting 500V via P2 Cal POT using 4:1 divider so 801 is dialed up to 125.00 Volts. Dial in 10 volts at a time, each time adding 2.50 Volts to the 801. By using the 0.01 range on the 801 you can see a 10 millivolt difference from the previous reading. The tolerance for each step is 12-1/2 millivolts. Note this difference. Then null with the "E" switch on the 801 and proceed by adding another 10 volts on the 412 and proceed in a similar manner to check the linearity of the rest of the resistors. To check the POT (Vernier) turn POT full clockwise and check as though it were another resistor on the X10 switch; except the tolerance is ten times as great, which means if this voltage stays on the scale of the 801 when adding 2.50 Volts in the 0.1 range its OK (Tolerance is 125 millivolts).

To check the X100 switch use the 4:1 divider start at 500V and null the 801 out to 125.00 Volts then add one resistor at a time. Each time nulling out the 801 and look for a difference of 25 millivolts for each step.

29. LINEARITY OF METER

With supply shut off zero meter with center screw on meter face, then turn supply on 500V must be within 60 Volts plus or minus or 3% of full scale. Add 100V at a time to 2000 Volts and if any any time meter reads more than 60 Volts off, dial voltage, reject meter.

30. PAINT POT P2

Dial supply up to 1300 Volts, calibrate 801 and set P2 till 801 reads exactly 325.00 Volts at 117 Volts line and paint Pot P2 with red fingernail polish.

31. TIME DELAY 100 V

Set line voltage at 100 Volts and turn on instrument then note the time it takes for CK1 to close in seconds. It must be less than 35 seconds.

32. TIME DELAY 130 V

Set line voltage at 130 Volts and turn on instrument then note the time it takes for CK1 to close in seconds. It must be more than 15 seconds.

If instrument fails to meet these tolerances in Steps 31 and 32, this can be remedied by changing the V9 trigger tube or adding a parallel resistor to either R50 or R51 or both of about 10 times of the original value.

33. STABILITY PER HOUR

Instrument should be read in the positive polarity every hour for four hours then switched to the negative polarity at the end of the four hours. The tolerance is 0.005% or 25 millivolts through a 4:1 divider and the tolerance should not exceed 25 millivolts between positive and negative polarities.

34. STABILITY PER DAY

During the stability per hour checks, the total variation cannot be more than 250 millivolts during the day when read through a 4:1 divider.

35. TECHNICIAN

36. DATE

Date the test was completed.

412 TEST RECORD

Serial Number			Tolerance				
1.	Visual Inspection						
2.	Ohmeter Check						
3.	Preliminary Check						
4.	Ballast Tube Reg.	100-130V	.3 - .7V				
5.	Ebb	117V	415-445				
6.	Eo Aux.	117V	265-275				
7.	Reg. Aux.	100-130V	<.240V				
8.	eo Aux.	117	.008V				
9.	e Line Min. Aux.		<95V				
10.	E Ref.	117	Approx. 167V				
11.	Reg. E. Ref.	100-130V	<.003				
12.	E across C3	117	Approx 3.2 kv				
13.	500V + line reg.	100-130V	.01%				
14.	500V + ripple	100-130V	<5 mv				
15.	500V + load	117V	.03% at 15 ma				
16.	500V - line reg.	100-130V	.01%				
17.	500V - ripple	100-130V	<5 mv				
18.	500V - lead	117	.03% at 15 ma				
19.	2 kv - line reg.	100-130V	.01%				
20.	2 kv - ripple	100-130V	<5 mv				
21.	2 kv - load	117V	.03% at 15 ma				
22.	2 kv - line min.	15 ma load	<100V				
23.	2 kv + line reg.	100-130V	.01%				
24.	2 kv + ripple	100-130V	<5 mv				
25.	2 kv + load	117V	.03% at 15 ma				
26.	2 kv + line min.	15 ma load	<100V				
27.	Linearity min Eo to Max Eo (see chart)		<.25%				
28.	X1 Pot Range		5%				
29.	Linearity of meter		.2%				
30.	Paint Pot P2						
31.	Time delay	100V	<35 sec.				
32.	Time delay	130V	>15 sec.				
33.	Stability per hour		.005%				
34.	Stability per day		.05%				
35.	Technician						
36.	Date						

Form 961A

NOTES:

1. RE1 THROUGH RE18 ARE 600V PIV SILICON DIODES.
2. ALL RESISTOR TOLERANCES 10% UNLESS OTHERWISE NOTED.
3. ALL PRECISION WIREWOUND RESISTORS WOUND WITH EVANOHM OR EQUIVALENT WIRE.
4. ALL DC VOLTAGES ARE REFERENCED TO MAIN NEGATIVE BUS (SHOWN HEAVY).
5. ALL DC VOLTAGES MEASURED WITH RESPECT TO NEGATIVE BUS AT 117V LINE, NO LOAD USING VTVM OR 20,000 OHM/V METER. MAIN OUTPUT SET AT 2,000V.

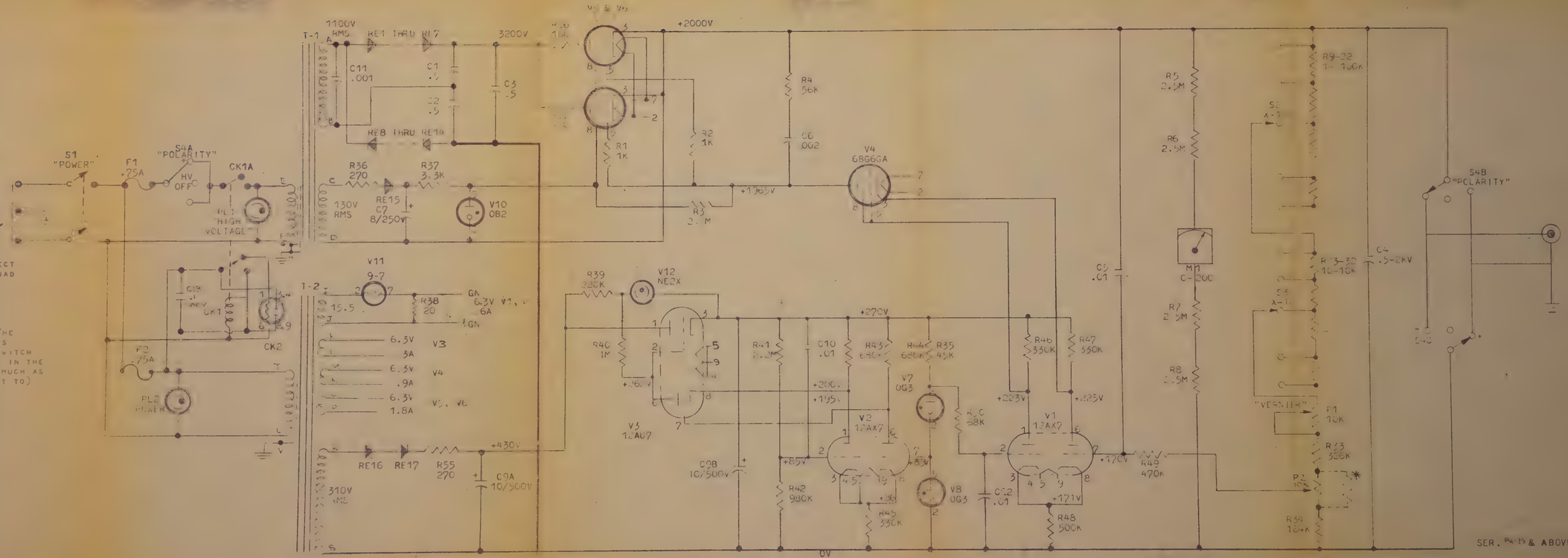
117V 50/60~

CAUTION:

THIS IS A SELECTIVE POLARITY SUPPLY. THE NEGATIVE BUS (SHOWN HEAVY) IS AT CHASSIS OR EARTH POTENTIAL ONLY WHEN POLARITY SWITCH IS IN + POSITION. WITH POLARITY SWITCH IN THE − POSITION, THE NEGATIVE BUS MAY BE AS MUCH AS 2,150 VOLTS BELOW (NEGATIVE WITH RESPECT TO) CHASSIS GROUND.

USE EXTREME CARE

✳ FACTORY SELECTED VALUE



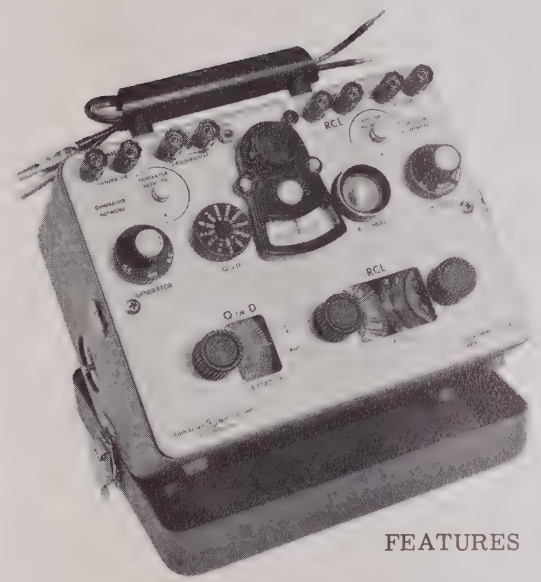
SER. 8415 & ABOVE

MODEL 412A DC POWER SUPPLY

FLUKE

TECHNICAL DATA

710A IMPEDANCE BRIDGE



FEATURES

High Accuracy

Wide Range

Compact Size

Rapid Operation

Versatility

Provisions for:
External Generators

Detectors

Q & D Rheostats

Capacitance Standards

APPLICATIONS

General laboratory use where it is desirable to measure resistance, capacitance, inductance, storage factor, and dissipation factor with one instrument.

Receiving inspection quality control.

Rapid checking of components on the production line.

Specialized applications such as measurements of remote capacitance, incremental inductance, and extremely small capacitance with an external standard.

GENERAL DESCRIPTION

The Model 710A consists of bridge standards arranged in a four-arm network, AC and DC generators, and AC and DC detectors. By simple switching, the standards may be arranged as a Wheatstone bridge for AC and DC resistance measurements, as a series or parallel capacitance bridge for capacitance measurements, and as either a Maxwell or Hay bridge for inductance measurements.

BRIDGE STANDARDS: All ratio arm resistors are adjusted to better than 0.05%, except for the 1 ohm and 1 megohm standards which are adjusted to better than 0.1%. All resistors using wire have a temperature coefficient of less than 20 parts per million per degree C. All variable wirewound resistors are accurate to 1% or better. The mica capacitance standard is a hermetically sealed precision unit adjusted to better than 0.1%. All standards are carefully selected for highest stability.

DETECTORS: A suspension galvanometer with 0.5 microampere sensitivity per division is used as a detector for all DC resistance measurements. A selective amplifier operating an electron-ray tube is used as a detector for AC measurements. The rapid response of the electron-ray indicator speeds operation and increases the precision of balance. The bridge is furnished with a plug-in RC network which tunes the detector amplifier for a maximum response at 1 kilocycle. Plug-in RC networks tuned to other frequencies, as listed below, are available as optional accessories. The amplifier may be used untuned if desired. In addition, terminals are provided so that the bridge may be used with an external AC or DC null detector.

GENERATORS: An RC oscillator using a plug-in RC component network provides excitation for all AC bridge measurements. A shielded isolation transformer is used to isolate the AC generator output to insure minimum error from capacitance effects. Internal DC power supplies are provided for DC bridge excitation. The proper voltages from these supplies are automatically selected for each range of measurement. This arrangement provides complete protection of the null detector and the ratio arms and permits the highest sensitivity of balance. The plug-in RC network normally provided for use in the oscillator is tuned for 1 kilocycle. RC networks tuned to other frequencies, as listed below, are available as optional accessories. Also, terminals are provided which allow use with an external AC or DC generator.

SPECIFICATIONS

RANGES

RESISTANCE: 0.1 milliohm to 12 megohms in 8 ranges, 0.1 milliohm per dial division on the lowest range.
ACCURACY: ±(0.1% + 1 dial division).

CAPACITANCE: 0.1 micro-microfarad to 1200 microfarads in 7 ranges, 0.1 micro-microfarad per dial division on the lowest range (NOTE: 0.01 micro-microfarad per dial division with an external standard).
ACCURACY: ±(0.2% + 1 dial division).

INDUCTANCE: 0.1 microhenry to 1200 henrys in 7 ranges, 0.1 microhenry per dial division on the lowest range.
ACCURACY: ±(0.3% + 1 dial division).

DISSIPATION FACTOR (D): 0.001 to 1.000 at 1 kilocycle.
ACCURACY: $\pm(2\% + 0.005 \times f_{kc})$.

STORAGE FACTOR (Q): 0.1 to 1000 at 1 kilocycle.
ACCURACY: $\pm(2\% + 0.005 \times f_{kc})$.

FREQUENCY RANGE: DC to 10 kc with optional plug-in RC networks shown below.

INPUT POWER: 115/230 volts, 50 to 800 cps, 12 watts.

SIZE: 9 inches long, 7 inches wide, 6-1/2 inches high.

WEIGHT: 10 pounds.

ACCESSORIES SUPPLIED: Power cord, test leads, operating instructions.

PRICE: $525.00 f.o.b. factory, Mountlake Terrace, Washington.

OPTIONAL ACCESSORIES: Plug-in RC networks tuned to the following frequencies for use in the detector and generator: 100 cps, 120 cps, 400 cps, 500 cps, 800 cps, 2 kc, 5 kc, and 10 kc. Price per pair, $40.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

3-1-62

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

710A TESTING PROCEDURE

Preliminary Tests

1. Ohmmeter check of ratio arm switch S6D and its associate resistors, R3, R4, R5, R6, R7, R8 and R9. Connect ohmmeter to the right hand EXTERNAL GENERATOR binding post and to the right hand EXTERNAL DETECTOR binding post with bridge disconnected from the power line. Rotate DETECTOR switch to AC and AC GAIN to about half turn. Turn GENERATOR switch to OFF. Turn GENERATOR LEVEL to OFF.

   Next rotate the ratio switch (center knob on bottom row) through positions, 0.1 ohm, 1 ohm, 10 ohms, 100 ohms, 1K ohm, 10K ohms, 100 K ohms and 1 megohm. The ohmmeter should read ten times each position indicated on the dial except the 1 megohm position (1K = 10K on ohmmeter). This is a continuity test and is a functional test not an accuracy test.

   Next transfer the ohmmeter lead from the right hand EXTERNAL DETECTOR binding post to the left hand EXTERNAL DETECTOR binding post and rotate the ratio switch through positions 100K ohm and 1 megohm. They should read 10K ohms and 1K ohm respectively. This checks the continuity of resistors R10 and R11.

2. Turn on tests. Install the line cord and plug into a suitable source of AC power and rotate the controls indicated as follows. GENERATOR LEVEL about one half turn clockwise and GENERATOR switch to AC. Next rotate the ratio switch to a blank space such as between 100 h and 0.1 ohm. Then set the multiplier switch (the lower right hand knob) so that it indicates 000 on the dials. The AC NULL indicator tube should show green. If not, there is trouble in the DC section of the power supply.

   Connect a VTVM to the left EXTERNAL GENERATOR terminal and the right RCL terminal. With the GENERATOR LEVEL control full clockwise, the VTVM should read 12 to 18 volts AC. This tests the output of the bridge AC GENERATOR. Connect the VTVM to the PHONES and G pin jacks and the output should be 35 to 50 volts AC with the AC GAIN full clockwise, the ratio switch to 1 megohm and the multiplier set at 000. This tests the AC DETECTOR gain.

   Connect the horizontal amplifier of an oscilloscope to the EXTERNAL DETECTOR binding posts and connect a 1000 cycle frequency standard (accurate to at least 0.1%) to the vertical amplifier of the scope. Adjust

the trimmer condenser C22 in the GENERATOR NETWORK so that the bridge frequency is zero beat with the standard frequency.

3. Check internal capacity, should be approximately 1.5 - 2 pf. Set QD switch to DX.01, QD dial, "D" scale to approximately 6. Ratio Arm to .0001 uf, Multiplier to 0.015. Gen. Level full clockwise, Det. Gain full clockwise. Readjust "D" dial and multiplier for balance, if necessary. This will provide function test for AC measurements.

4. To check internal bridge resistance of 3.5 to 4 milliohm.

   a) Zero adjust galvanometer.

   b) Set ratio arm to .1Ω and multiplier to 0.03 or 0.04.

   c) Detector control to DC and detector switch to shunted galvanometer.

   d) Rotate GENERATOR LEVEL clockwise and GENERATOR switch to DC.

   e) Null the bridge, then set the DETECTOR switch to GAL DIRECT, and rebalance the bridge. A more sensitive External Galv. may be used.

   Ratio Arm check. Use External Galvo. of high sensitivity. Set multiplier to X1.0000. Connect resistance standards to RCL posts starting with .1Ω position on Ratio, checking 1Ω, 10Ω, 100Ω, 1KΩ, 10KΩ, 100KΩ and 1 megohm for ±.1% tolerance as read on galvo, not on bridge. If resistances are within tolerance, we can assume for the moment the 1KΩ multiplier, and 10K on arm opposite is in tolerance. If all readings are high, either 1KΩ on multiplier is too <u>low</u> or 10K on opposite arm is too high.

5. Multiplier Check. Use external Galv. of high sensitivity. Set Ratio Arm to 1KΩ position. Use a Decade Box or equivalent of .02% or better accuracy.

(1) Set Multiplier to	Set Standard to	(2) Set Mult to	Set Stand. to
1.00K	1.00K	1.10K	1.10K
2.00K	2.00K	1.20K	1.20K
4.00K	4.00K	1.40K	1.40K
6.00K	6.00K	1.60K	1.60K
8.00K	8.00K	1.80K	1.80K
10.00K	10.00K	1.905K	1.905K

Check for ±.1% Tol. on Galvo.

6. Inductance Standardization. Connect a 1 hy ±0.1 standard to the Unknown RCL terminals. Set the ratio dial to 100 mh and the multiplier dial to 10.00. Rotate the GENERATOR switch to AC and the GENERATOR LEVEL full clockwise. Rotate the DETECTOR switch to AC and adjust the DETECTOR GAIN control just enough to close the AC NULL. Set the Q & D switch to QX1 and adjust the QD dial to maximum opening after setting the trimmer capacitor C2 about halfway in. The bridge should read 10.03, if not and the bridge reads out of tolerance on the low side, C1 is too high. If the bridge reads out of tolerance on the high side, it is then necessary to pad the standard capacitor C1 with a silver mica trimmer capacitor. 10 uufd of trimmer capacitance is required for each minor division of the Multiplier dial. The Q dial should read about 10+.

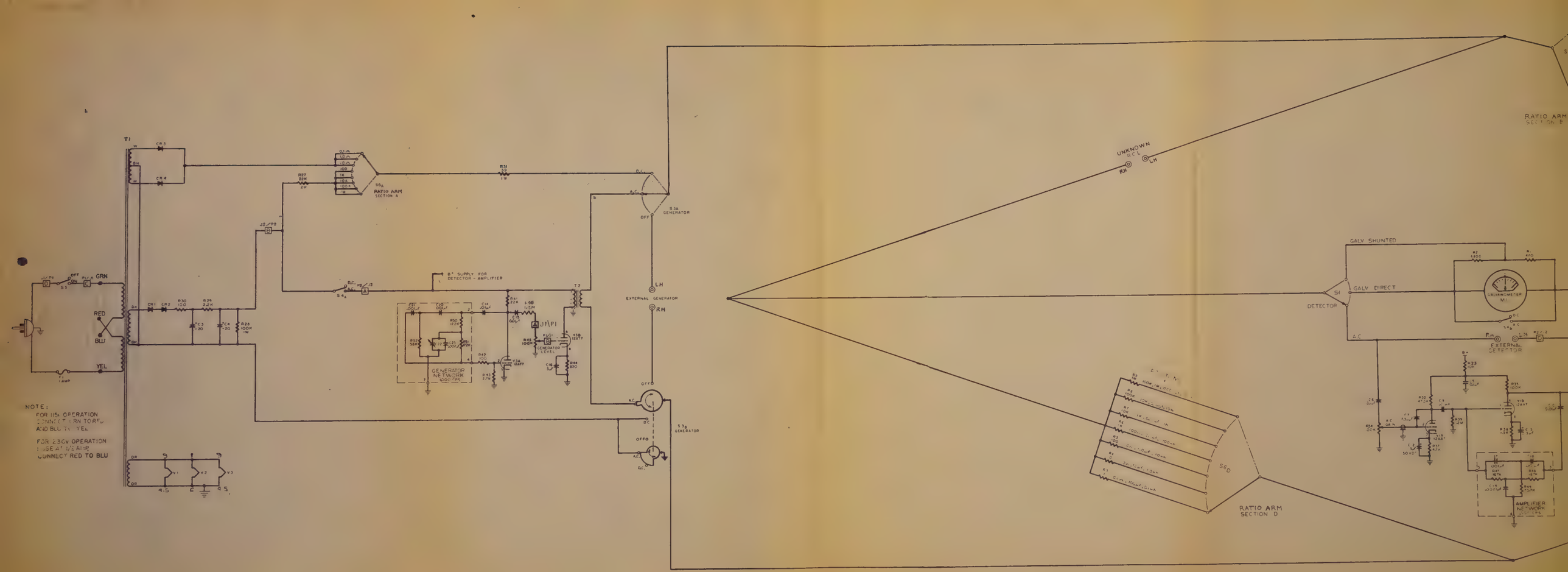
   The bridge will next be checked against a 5 mh ±0.1% standard. The ratio dial is to be set to 1 mh, the multiplier to 9.9910 and with the other controls set as for the 1 hy measurements, the bridge should read 9.997 for balance and the Q dial will read about 7. Adjust the trimmer C2 to bring well within tolerance and recheck with the 1 hy standard. Lock the trimmer capacitor.

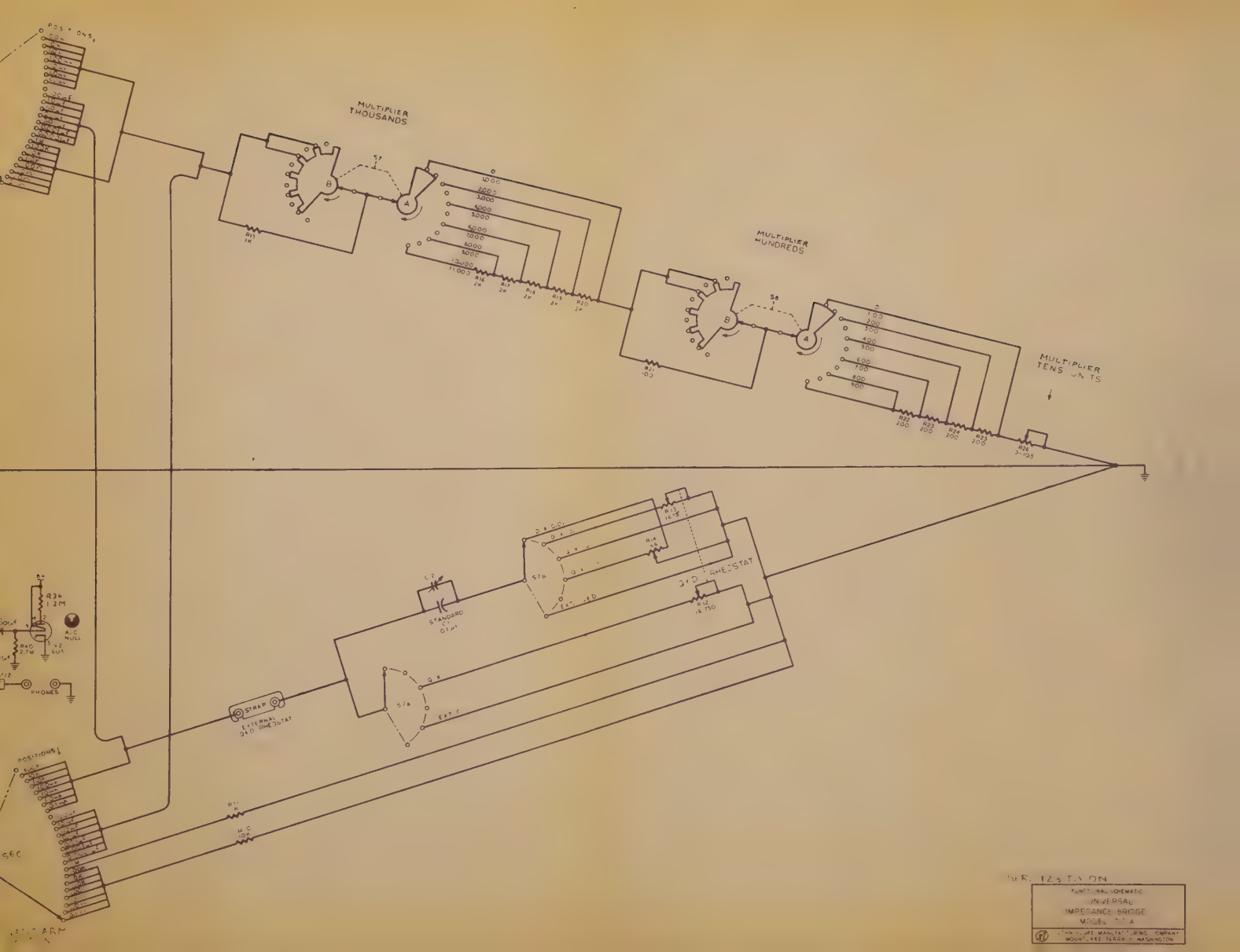
7. Capacitance Standardization. Connect a .01 uf ±.05% standard to the RCL binding posts. Set the QD switch to Dx.01 and the QD dial to zero. Next rotate the ratio switch to .001 uf, then set the multiplier to 9.990. Adjust the Gen Level to full clockwise. Adjust the DETECTOR GAIN to full clockwise. The bridge should null between 9.980 and 9.995. NOTE: If the D of the standard capacitor under measurement is too low to balance on the D dial, shunt a carbon resistor of about 1 megohm across it.

   Next connect a .1 mfd ±.05% standard capacitor to the bridge as for the .01 uf measurement and set the ratio switch to .01 uf. Readjust the GENERATOR LEVEL and the DETECTOR GAIN if necessary. The bridge should null at 9.980 to 9.995. NOTE: Connect about 300K ohms across the standard capacitor if it is not possible to get a good null on the QD dial.

   Resistance - Check at 12 megohms using the 12 megohm standard resistance provided.

   Inductance - Will be checked at 10 h using a General Radio 10 h inductor.


T1
CR3
CR4
CR1
CR2
R30 100
R29 2.2K
C3 .30
C4 .20
R26 100K 1W
JI/PI
GRN
RED
BLU
YEL
OFF
S5
F1 1 AMP
115
230
4.5
6
4.5
NOTE:
FOR 115v OPERATION
CONNECT GRN TO RED
AND BLU TO YEL
FOR 230v OPERATION
USE A 1 1/2 AMP
CONNECT RED TO BLU
R27 22K 2W
J2/P2
S6a
RATIO ARM
SECTION A
R31 33 1W
S3a
GENERATOR
OFF
A.C.
D.C.
S4
B+ SUPPLY FOR
DETECTOR - AMPLIFIER
GENERATOR
NETWORK
1000 CPS
R41 22K
C14 .02µf
C15 .005µf
R40 100K
GENERATOR
LEVEL
V1B 12AT7
R42 100
V2A 12AT7
R43 2.7K
C16 .5µf
R44 820
T2
EXTERNAL GENERATOR
LH
RH
OFF
S3b
GENERATOR
UNKNOWN
RCL
LH
RH
S6b
RATIO ARM
SECTION B
RATIO ARM
SECTION D
GALV SHUNTED
GALV DIRECT
S1
DETECTOR
GALVANOMETER
M1
EXTERNAL
DETECTOR
V1A 12AT7
V1B 12AT7
AMPLIFIER
NETWORK
1000 CPS


MULTIPLIER THOUSANDS
MULTIPLIER HUNDREDS
MULTIPLIER TENS UNITS
STANDARD C1 .01 μf
STRAP
EXTERNAL 2ND TIME STAT
2ND TIME STAT
PHONES
A.C. NULL
FUNCTIONAL SCHEMATIC
UNIVERSAL
IMPEDANCE BRIDGE
MODEL 1654-A

FLUKE

TECHNICAL DATA

910A TRUE RMS VOLTMETER

Features:

- Root Mean Square Response
- Broad Bandwidth
- High Accuracy
- High Input Impedance
- High Sensitivity
- Fast Response
- Amplifier Output

INTRODUCTION

Model 910A is the only instrument available today which combines the ability to make true RMS measurements at high accuracy with extremely broad bandwidth. The conversion of the input AC to a DC voltage directly proportional to the effective heating value of the input AC voltage is accomplished by a low impedance thermocouple. This thermocouple is situated in the feedback loop of a sensitive DC amplifier and is chopper stabilized to operate at a constant level. Because the thermocouple is operated in this manner, the Model 910A responds very rapidly to any change in input voltage. The thermocouple amplifier is preceded by an AC amplifier which features 60 db midband feedback, 100 uv maximum sensitivity, 10 megohm input impedance on all ranges, and completely protects the thermocouple from damage under any condition of overload.

Model 910A also incorporates the following features not generally found in commercial voltmeters: (1) A regulated DC filament supply to eliminate both meter fluctuation due to line voltage transients and meter beating when measuring frequencies near the input line frequency; (2) a high gain, wide band AC output which allows the Model 910A to be used simultaneously as an amplifier or voltmeter; (3) a 5 inch expanded, mirrored scale meter; and (4) cabinet sides which may be readily removed for easy access to the interior of the instrument.

APPLICATIONS

The Model 910A may be used to accurately measure virtually any AC voltage regardless of waveform. This includes:

Noise and microphonics.

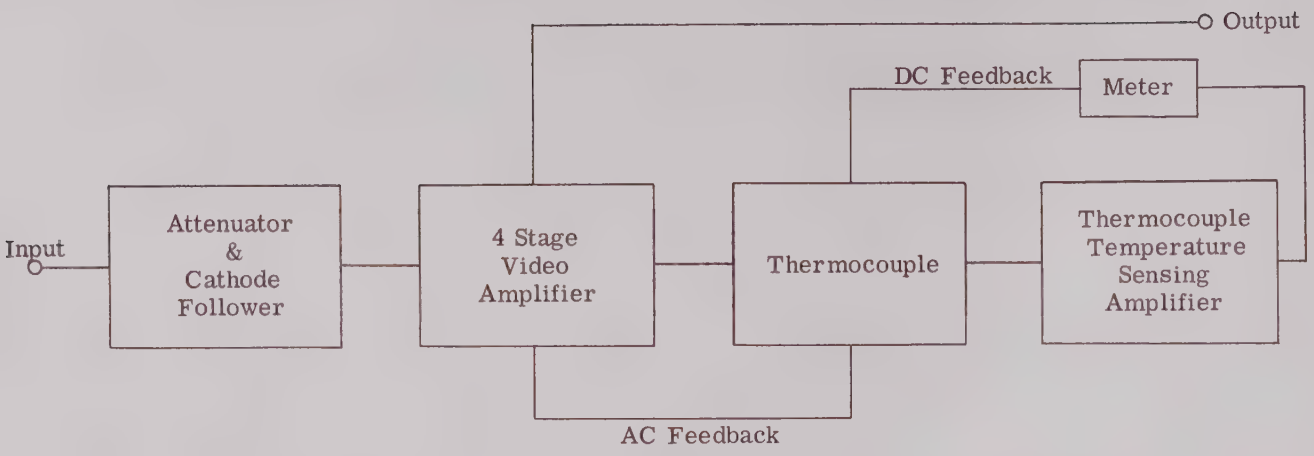
Frequency response measurements.

Total harmonic and intermodulation distortion.

Currents and losses in transformer coils, magnetic amplifiers.

RMS ripple voltage.

Audio and video power.



FUNCTIONAL DIAGRAM - MODEL 910A RMS VOLTMETER

Specifications

VOLTAGE RANGE: 0.1 mv to 300 v in twelve ranges with full scale readings of:

0.001	0.100	10.0
0.003	0.300	30.0
0.01	1.000	100.0
0.03	3.000	300.0

DECIBEL RANGE: -75 to +52 dbm in 12 ranges.

FREQUENCY RESPONSE: 10 cps to 7 MC.

ACCURACY:

±1% of full scale	50 cps to 800 KC
±2% " " "	20 cps to 2 MC
±3% " " "	20 cps to 3.5 MC
±5% " " "	10 cps to 7.0 MC

CREST FACTOR: Nine at range switchoverpoint (1/3 scale) to three at full scale.

INPUT IMPEDANCE: 10 megohms shunted by 30 uuf on ranges from 0.001 v to 0.300 v.
10 megohms shunted by 15 uuf on ranges from 1.0 to 300 v.

AMPLIFIER: Output terminals provide an output which is approximately 100 mv RMS at full scale, regardless of range. Output impedance is approximately 50 ohms over entire range.

INPUT POWER: 115/230 v ±10%, 50 to 60 cycles, approximately 80 watts.

SIZE: Cabinet: 10-1/2" high, 7-1/4" wide, 15" deep.
Rack: 5-1/2" high, 19" wide, 13-1/4" deep.

WEIGHT: Cabinet: 20 pounds; Rack: 19 pounds.

PRICE: Cabinet: $545.00. Rack: $565.00. Prices f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

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Electronics FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.
P. O. Box 7428 • Seattle 33, Washington
PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

910A TEST PROCEDURE - LONG FORM

I. PRE-POWER TEST

A. Inspection:

Each instrument will be thoroughly Q.C. inspected before reaching this point. Visual inspection should be unnecessary; however, wiring errors may exist and may be partially found using the cold resistance checks below.

B. Cold Resistance Checks (Use Triplett or Simpson VOM):

1. Across power plug prongs (power switch on, 115V operation 3.8Ω ±.5Ω check_____

Following measurements made from the point to the chassis:

2. One power prong. ∞ check_____
3. V9, pin1(250V supply) 10 k to 20 k check_____
4. V9, pin 5 (filament) 700 k check_____
5. Emitter 2N301W .5 to 1.0 check_____
6. -75V (Purple wire near Q1) 68 k check_____
7. V6, pin 9 1500Ω check_____
8. V2, pin 1, 85Ω ±5Ω check_____
9. V5, pin 7, 20 k - 30 k check_____

II. TURN ON

Equipment: Variac, ac voltmeter accurate to 2% between 100-130V AC, ammeter .5-1.5 ampere range, ac-dc VTVM, 400D or 910A, audio oscillator.

A. Settings

1. Set RANGE SWITCH to 300V.
2. Set DAMPING to LO
3. Turn POWER switch ON.
4. Center panel ZERO.
5. Center all internal pots (7) and trimmer capacitors (4).

B. Remove V5.

C. Set variac to zero, plug instrument in and gradually increase input voltage, keeping input current below 1 ampere to 115 volts. Allow 1 minute warmup. check_____

D. Set R66 below chopper to zero meter. If this cannot be done, trouble shoot dc amplifier or power supplies. check_____

E. Power Supplies - Using VTVM set power supplies in order shown below:

1. +253V (red wire) use R106 check_____
2. -75V ±5V no adjust check_____
3. -6.3V V2 pin 4, R86. check_____

F. Power Supply Ripple (115V Line) and Regulation

1. (a) Measure +253V ripple at 115V line with 400D, 910A (less than .7 mv) record _____mv

   (b) Lower line till ripple goes up markedly (low line regulation) less than 100V AC record line _____V AC

2. Repeat (a) and (b) above for -75V and -6.3V

   (a) -75V less than 20 mv _____mv
   (b) -75V less than 100V ac _____V AC

   (a) -6.3V less than 10 mv _____mv
   (b) -6.3V less than 100V ac _____V ac

G. Plug V5 in. Meter should settle back to zero in 30 seconds. If meter reads upscale, look at OUTPUT with a 20 to 30 mc/s oscilloscope with .05 mv/cm sensitivity. Look for oscillation or pickup and trouble shoot accordingly. check_____

H. V2 Microphonics: Wrap instrument moderately hard with fist. Microphonics should cause less than 10% F.S. meter deflection. If more replace V2. check_____

I. V1 Microphonics: Short INPUT with a shorted plastic GR plug, set RANGE SWITCH to .001V. Repeat "F" and replace V1 if deflection exceeds 30%. check_____

J. Pickup: Leave RANGE SWITCH at .001V and short INPUT. View output on an oscilloscope at 5 mv/cm sensitivity. 60 c/s and 120 c/s pickup should be less than 1 cm pp. If higher, set RANGE SWITCH to .01V. The pickup should reduce markedly. If it does problem is poor bonding between front panel and chassis. If it does not decrease, look for missing shields or defective components in ac amplifier. check_____

K. DC amplifier gain: Remove V5 and carefully zero meter. Connect 250 k across C31 and C32 using their tie points. Meter zero should move upscale no farther than the edge of the green zone. If it moves farther, dc amp gain is low. check_____

L. Function Check. Replace V5: Set RANGE SWITCH to 1.0V, remove short and apply a signal of approximately .9V to the input with an audio oscillator. Monitor the input voltage with a 400D or 910A. Error between instruments should be less than 10%. Repeat with .25V input on .3V range. check_____

M. Noise Check: With approximately .9V input on the 1.0V range and both sides on the instrument (or top and bottom for 910AR) look for meter noise. Random deflections should be less than 1/2 small division peak to peak. Instrument should not be in a strong draft. If greater than this, check again at .25V in a .3V range. If the noise reduces, trouble is in the cathode follower. check_____

N. Crest factor check: Apply a 400 cycle signal which reads 7 volts on the 10V range. With this input, turn to 3V range. View output with an oscilloscope and look for clipping at negative peak. Clipping will be caused by V5 or its screen, cathode or plate resistors. check_____

O. Allow 48 hours on time before beginning calibration.

III. CALIBRATION

Equipment:

1. Variac and ac voltmeter 100-130V.
2. H-P 400 cycle calibrator 738AR.
3. H-P high frequency test set 739AR.
4. Metal tip insulated tuning screwdriver.
5. 803
6. H-P 200SR audio oscillator.
7. Test leads, coax adapters and 52Ω coaxial feedthru termination with UHF connectors.

Allow instrument to warm up for 1/2 hour or for time necessary for cabinet to reach equilibrium temperature, whichever is less. If power is interupted, allow at least 5 minutes warm up. Allow 1/2 hour warm-up of 738AR and 803.

With instrument warm, short the meter terminals with clip leads or a screwdriver and carefully mechanically zero meter turning the adjustment screw in the opposite direction of desired meter motion.

A.

1. With 801 or 803 set B+ to 253.2V ±.2V at 115V line. check_____

2. Set line to 105V and record shift in B+ (less than .4V.) Also note meter zero shift. Should be in green area after short time. check_____

   Set to 130V line. Record B+ shift. Check meter zero shift. check_____

3. Set -6.3V dc filament to 6.3 ±.1V. Measure V2, pin 4. 115V line check_____

B. Switching Transients: Connect 738AR to 910A with 52Ω coax. (no termination). Set 738AR to 0V. Slowly advance range switch toward 300V and observe transients on the meter. Then slowly return to 1 mv. Transient should never be more than 1/4 f.s. If larger, check C.F., especially C9. check_____

C. Set line to 115V, damping to low, range switch to 10 mv. Apply 10 mv from 738AR calibrator and adjust R37 (400~ Cal Adj. pot) to exactly 10 mv. check_____

D. 1000:1 Resistive Divider Adjust: Set range switch to 1V. Apply 1V with 738AR. Set R3 to read exactly 1V on the meter. Make sure R3 is at least 20 degrees from a stop. check_____

E. Range resistors: Apply F.S. 400 cycle on ranges 1 mv through 300 volts. There should be no error on the meter. (1/4 percent F.S. except 1.0 mv may read 1/4 to 1/2% high.) check_____

F. Meter Tracking: Check all cardinal points on the meter using 3V and 1V ranges. Error should be less than plus or minus .5% F.S. If greater, replace meter and start C. again. check_____

G. Low Frequency Calibration: Connect 200SR OUTPUT to 739AR INPUT with 50Ω coaxial cable and connect a second coaxial cable from the 739AR output to the feedthrough termination.

Connect the termination output to the 910A INPUT. Set the 200SR to 100 c/s and the 739AR ATTENUATOR to 1.0V. Set 910A RANGE SWITCH to 1.0V and adjust 200SR for a 1.0V reading on the 910A. Set the 739AR meter to the upscale reference mark. Switch the 200SR to 10 c/s and readjust its AMPLITUDE to give the same reading on the 739AR meter. Do not use the meter set for this. Response at 10 c/s should be between -1.5% and -2.5%. If down more than 2.5% raise R41 from 2.7 m to 3.3 m. If more than 1.5% high, lower R41 to 2.2 m. Errors beyond these indicate one or more defective components in the ac amplifier or cathode follower.

check_____

H. AC Amplifier High Frequency Calibration: Set the 739AR for 300 kc/s and .001V output range and connect terminated coax to 910A. Set 910A VOLTS to .001V and adjust AMPLITUDE to 0 db. Set frequency to 7 mc and adjust R48 for 0 db. Set at 10 mc/s and observe reading change. Adjust R48 and C23 so that response is flat to 7 mc/s and down .3 to .5 db at 10 mc/s. To raise response at 10 mc/s turn R48 clockwise. See that C23 is not at an extreme of adjustment. Sweep down from 7 mc/s to 3 mc/s and look for rising response. Response should rise less than .15 db.

check_____

I. 1000:1 Capacitive Divider Adjustment, H.F.: With the method in Section J, set up 1000:1 divider roughly to ±3%. Check response in 5-7 mc/s area on .001V range and then check 1.0V range. The difference in response should be adjusted by replacing R5. Lower R5 to lower response and raise it to raise response. Set response on 1.0V range to within ±.15 db of response on .001 range at 7.0 mc/s.

check_____

J. 1000:1 Capacitive Divider Calibration: Set the 200SR to 400 c/s and adjust its amplitude and 739AR attenuator to give exactly 1.0V reading on the 910A set on 1.0V. range. Set the 739AR meter set to the top reference mark. Next set 739AR for a 300 kc/s output and adjust its amplitude for exactly the same reading on its meter. Rock selector switch back and forth to check for meter motion.

Adjust trimmer C2 for exactly 1.0V with 300 kc/s input. (Reading will fall about 1% when screwdriver is removed.) Switch back to 400 c/s and look for motion of 910A meter. Before adjusting C2, if calibration at 300 kc/s was off by more than 15%, repeat parts "D" and "I".

check_____

K. Adjust 739AR for 1V output at 400 cycles, connect to 910A under test. Shift frequency of 739AR to 4 kc and 30 kc. Change in 910A reading should be less than 1/2%. If greater, move wire adjacent to the 10 megohm resistor (R1) to adjust frequency response, recheck Step J.

L. .003V - Set 739AR and 910A to .003. Adjust AMPLITUDE to 0 db at 300 kc. Switch to 3.0 mc and set C13 (on range switch) to give exactly 0 db again. Sweep to 7 mc. If down more than .15 db change R19 to next higher 10% value (i.e. 270Ω to 330Ω). Next repeat the procedure. Record value used, if changed. R19 =_____Ω

M. .01 - Repeat procedure for .003 range on this range but change R20 to get proper response. R20 final value is _____Ω Adjust C14, (Check if not changed)

N. .03 - This range has no adjustment but should be flat within ±.2 db between 3 and 7 mc. Record error _____db at _____mc

O. .10 Range - No adjustment, record maximum error between 3 and 7 mc. _____db at _____mc

P. .30 Range - Same as .10 range _____db at _____mc

Q. 3.0 volt range - If the 1000:1 divider is set up properly, this range will have the same response as the .003 range.

10V and above - If procedure is followed to this point, all ranges should be calibrated.

This completes high frequency calibration.

IV. FINAL TESTS

A. Line Voltage vs. Calibration: Apply .8 mv at 7.0 mc/s on .001 range. Drop to low line, 105V. Reading should not go below .785. Set line to 128V, reading should not go above .816, check_____

B. Final check: Apply 400 cycles from 738AR and check full scale accuracy on ranges .001 to 300V. Instrument should read exactly F.S. except as noted before.

C. Replace covers and set controls as follows:

1. Power switch off
2. Range switch to 1.0V
3. Damping to Lo.

This completes test procedure

3/7/62

910A CALIBRATION REPORT

Date: _____
Serial No. _____
Technician: _____
_____

I. Cold Check

1. Power Prongs 3.8Ω ±5%
2. V9 (250V supply) 10 k - 20 k
3. V9 pin 5 700 k
4. Emitter 2N301W .5 - 1.0Ω
5. -75V purple near Q1 68 k
6. V6 pin 9 1500Ω
7. V2 pin 1 85Ω ±5Ω
8. V5 pin 7 20 - 30 k

II. Turn On with Variac, V5 out

1. Zero meter R66
2. Power supplies
   set 253V
   check -75
   check -6.3V dc
3. Ripple 115V 253V supply <.7 mv _____mv
   Low line reg. 253V <100V ac _____V ac
4. Repeat (3) for -75V <20 mv _____mv
   <100V ac _____V ac
5. Repeat (3) for -6.3V dc <10 mv _____mv
   <100V ac _____V ac
6. Replace V5
7. Microphonics 300V <10% FS _____
   .001V shorted <30% FS _____
8. Pickup scope on output .001V <5 mv pp _____mv pp
9. DC amp gain V5 out 250 k across C31 & C32 (shift from zero within green area) _____
10. Function check .9V 400 cycle 1V range
11. Noise check .9V 1.0V range <1/2 SD pp _____pp
12. Crest factor 400 cycle 7V, 10V range switch to 3V, no clipping _____
13. Drift check. (Set zero at 3 min. Check at 10 min. and 1 hour) _____

III. Calibration - 1/2 hour warmup

1. Set 253.2V ±.2V 115V ac
   105V shift <.4V _____V shift
   130V shift <.4V _____V shift
2. Set -6.3V ±.1V V2 pin 4
3. Switching transients 0V in <1/4 FS _____max.
4. ac amp cal .01V range 400 cycles R37
5. 1000:1 divider 1.0V 400 cycle R3
6. Range resistors 400 cycle .001V - 300V <.25% _____max.
7. Meter tracking 1V - 3V ranges _____% FS max.
8. Low freq. cal. check 10 cycles <2.5%
9. High freq. cal. .001V R48, C23 set to 0 db
   7 mc - .2 db to -.7 db 10 mc
   Sweep down to 3.0 mc hump <.15 db +-_____db

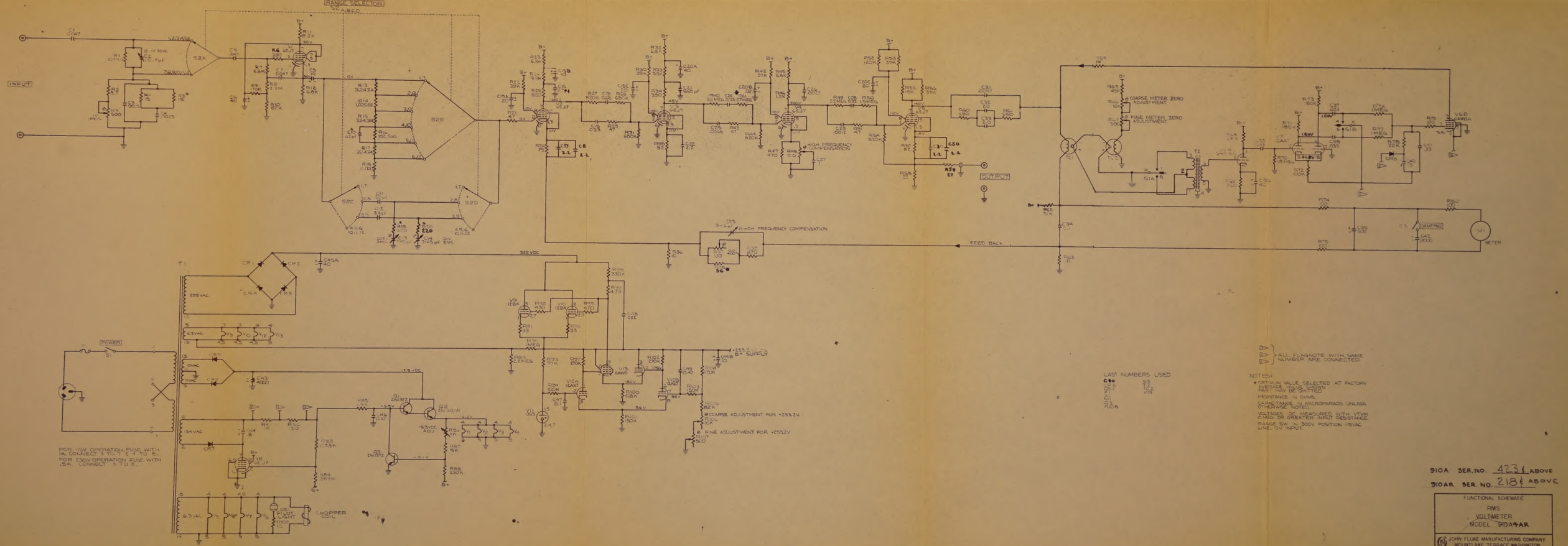
10. 1000:1 divider 7 mc cal adj. R5 ±.15 db at 7 mc + -_____db
11. 1000:1 divider capacitance adj. 1.0V 300 kc
12. .003V adj C13 at 3 mc, down less than .15 db 7 mc
13. .01V 3 mc Repeat (12) procedure.
14. .03 within .2 db at 7 mc _____db at__mc
15. .10 check 7 mc error .15 db _____db at__mc
16. .30 check 7 mc error .15 db _____db at__mc
17. 3.0V check at 7 mc (same as .003V) _____
18. 4 kc and 30 kc _____

IV. Final Tests

1. Line V5 .001V 7 mc cal shift from 115V - 105V ac .15 db _____shift
   115V - 130V ac .15 db _____shift
2. Set power switch off, Range 1.0V, damping low

Check only, unless units are asked. No check mark required if there is no dash.

COMMENTS:



910A SER. NO. 4231 ABOVE

910AR SER. NO. 218 ABOVE

FUNCTIONAL SCHEMATIC
RMS VOLTMETER
MODEL 910A/AR

JOHN FLUKE MANUFACTURING COMPANY
MOUNTLAKE TERRACE, WASHINGTON